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DEVELOPMENT OF A LOW LIGNIN HULL, HIGH ENERGY OAT AS A SUPERIOR RUMINANT FEED GRAIN FOR DOMESTIC AND EXPORT MARKETS

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Development of Low Lignin Hull, High Energy Oat as a Superior Ruminant Feed for Domestic and Export Markets

ADF Project # 20020212 Re. 22AC

B.G.Rossnagel, T.Zatorski, G. Scoles, G.Arganosa
Crop Development Centre/Plant Sciences Department

V. Racz, D.Christensen, L.Fuhr, G. Zalinko, J. McKinnon
Prairie Feed Resources Centre/Department of Animal & Poultry Science

College of Agriculture and Bioresources
University of Saskatchewan

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Abstract

This project was supported by the Saskatchewan Agriculture Development Fund, Super Oats Canada Ltd., the Crop Development Centre and the Prairie Feed Resources Centre, University of Saskatchewan. Objectives were the development of oat germplasm combining the low acid detergent lignin hull (LLH) and high oil groat (HOG) traits and proof of concept animal nutrition trials to validate the concept that this trait combination provides a valuable new ruminant feedstuff for prairie oat growers and cattle feeders. The project was conducted as planned. The LLH-HOG variety **"CDC SO-I"** was supported for registration in February 2006 and registered July 25, 2006 under CFIA registration number 6164. CDC SO-I has been released to FarmPure Seeds, Regina, SK for Pedigreed seed production and increase with Select plot production underway during 2006. The CDC also provided non-pedigreed seed to FarmPure Seeds for rapid increase for market development purposes. Improved LLH-HOG germplasm under development is at all stages of the CDC oat breeding program and Super Oats Canada Ltd. has committed to a further five years of funding to assist the CDC in continued development of superior LLH-HOG cultivars. 2006 trials were successful, with moderate yields and excellent physical grain quality. More than 50 LLH x HOG crosses are at various breeding program stages from F1 to advanced regional yield testing with initial CDC LLH-HOG selections being recycled as breeding program parents. From the PFRC proof-of-concept portion of the project, a dairy cow feeding trial and a sheep digestibility study were completed. The diet formulated with LLH-HOG oat (which had less than desirable physical grain quality due to the terminal drought stress during 2003 production) showed superior milk yield vs the barley control diet, however milk protein was reduced. 2004/05 and 2005/06 saw a 20 steer digestibility trial conducted, two large feedlot backgrounding and finishing studies (400 and 240 beef steers respectively at the U of S Research Feedlot) and a farm scale processing study using 124 calves at the Termunde Farm completed. For the backgrounding study the LLH-HOG diet was equal to the barley control. The results from the processing study were also encouraging as the calves fed unprocessed LLH-HOG demonstrated equal performance to those fed the processed (rolled) diet warranting further investigation of this positive, economically beneficial effect. The finishing study indicated less than adequate LLH-HOG intake and further experiments are required to investigate this issue. A new ADF supported project (J.J.McKinnon as PI) to further investigate the use of LLH-HOG oat in beef finishing diets began in 2006-07.

Executive Summary

This project was supported by the Saskatchewan Agriculture Development Fund, Super Oats Canada Ltd.; the Crop Development Centre and the Prairie Feed Resources Centre, University of Saskatchewan.

General objectives were to further evaluate the feeding value of LLH (low acid detergent lignin hull) and HOG (high groat fat/oil) oat (referred to as LLH-HOG oat) and, using accelerated plant breeding techniques, to combine these characteristics to develop a superior LLH-HOG feed grain oat characterized by a low lignin/highly digestible hull, > 8% groat fat, high groat yield (80%) and premium agronomic performance for Saskatchewan producers. The project was successfully completed.

CDC portion of project: The CDC handled two basic aspects: (1) production and procurement of LLH-HOG grain and seed for PFRC proof of concept trials and (2) development and evaluation of LLH-HOG oat adapted to Saskatchewan.

Under (1) the CDC provided seed of prototype LLH-HOG oat and organized production of or produced sufficient quantities of LLH-HOG grain for all feeding studies conducted by the PFRC/Animal and Poultry Science Department throughout the project.

In addition to the 2003 contract production at Saltcoats, SK of initial LLH-HOG prototype seed stocks and LLH-HOG grain for initial dairy feeding trials, this activity was highlighted by growing 140 acres of LLH-HOG oat at the CDC's Nassar Farm and some 50 acres at the Animal & Poultry Science University Farm resulting in the production of some 325 tonnes of LLH-HOG grain during the 2004 growing season (probably the largest research trial of this nature with a prototype cultivar ever undertaken in Canada).

Under (2), a new, simpler hull colouration LLH screening methodology was refined and is being used to select for the LLH trait, a putative molecular marker for the LLH trait was identified, and it was determined that the LLH trait was simply inherited and strongly associated with brown hull colour. Some 50 new LLH-HOG crosses were made during the project and were and are being processed using standard breeding protocols throughout the CDC breeding program. Single seed descent and NZ winter nurseries were used to speed the breeding process.

While demonstrating the LLH trait and % groat fat values ranging from 50 – 100% above normal checks, most initial selections had smaller, less plump grain and lower yield than top cultivars such as CDC Dancer, AC Morgan and CDC Orrin. However, several LLH-HOG selections with 50% > fat, reasonable physical grain quality, good % groat and yield equal to CDC Dancer were selected and advanced for further testing in 2006. Since the first CDC LLH-HOG crosses were only made in 2000 this rate of progress is more than acceptable.

Advanced CDC LLH-HOG selections were evaluated in 2003 through 2006 yield trials at up to five western Canadian locations, with selection SO02177 advanced to the 2004 WCoop trials as OT3012 and sister selection SO01174 advanced to the 2004 Rust Area Test. SO02174 was subsequently advanced to the 2005 WCoop trial as OT3017. It was subsequently supported for registration by the PRRCG Barley and Oat subcommittee in February 2006 and registered as CDC SO-I on July 25, 2006. CDC SO-I has been released to FarmPure Seeds, Regina, SK for Pedigreed seed production and increase which began in 2006. Using non-pedigreed seed produced at the CDC during 2004 and 2005, SuperOats Canada began market development increases and that program in 2006. As result of these successful activities, as of July 2006, SuperOats Canada has committed to a further five years of funding to the CDC in support of continued development of superior LLH-HOG oat varieties.

PFRC portion of project: This portion of the project had as its objectives: 1) to determine in vitro/in situ digestibility (IVDMD & ISDMD) of LLH-HOG oat and its constituent behavior to allow modeling of diet formulation to maximize LLH-HOG value, 2) using sheep and cattle models, evaluate feed intake and energy digestibility of LLH-HOG oat and 3) to determine the LLH-HOG oat value relative to conventional oat and barley in dairy production and beef feedlot (backgrounding and finishing) trials.

A dairy cow feeding trial and a sheep digestibility study using LLH-HOG produced during 2003 were completed during 2004/05 with an MSc thesis (Mr. Leland Fuhr, supervised by D.A.Christensen) describing the results completed during 2006. Results were encouraging in that the diet formulated with LLH-HOG oat (which had less than desirable physical grain quality due to the terminal drought stress during production in 2003) showed superior milk yield vs the barley control, however milk fat and protein were reduced. The LLH-HOG diet exceeded the Derby oat and barley diets in terms of milk yield at 42.1, 39.3 and 40.0 kg/day respectively. Results from the nutrient characterization and digestibility trial conducted with sheep indicated that fat and ADF digestibility increased with oat versus barley and was as expected for LLH-HOG oat. Nylon bag digestibilities suggested similar characteristics when LLH-HOG oat was compared with corn and barley. This data confirmed the value of the characteristics of an LLH-HOG oat type.

Mr. Grant Zalinko, an MSC candidate under the supervision of J.J. McKinnon, started on the project in July 2004 and conducted full scale beef back grounding and feedlot studies using the LLH-HOG prototype grain produced during 2004 and 2005. The feedlot trials were preceded by steer digestibility trials to quantitate the energy content of the LLH-HOG relative to standard control feeds.

In the digestibility trials LLH-HOG oat did not show equal digestibility to barley and, in some cases, digestibility was lower for the LLH-HOG oat particularly when at higher levels in the diet. The feedlot back grounding trial showed a significant positive response for LLH-HOG oat versus barley for both gain and feed efficiency. In another back grounding study at the Termuende farm, there was no effect of processing (rolling) LLH-HOG oat versus feeding whole LLH-HOG oat. This result would have significant economic effect by reducing input cost and warrants further investigation. The large feedlot study comparing corn, barley, and LLH-HOG oat finishing diets showed significantly poorer performance for the LLH-HOG oat largely due to significantly lower dry matter intake. While processing effects, where the hull was removed from the LLH-HOG oat during rolling, were a possible cause of lower feed intake, it was most likely a result of excess unsaturated fat in the diet. Carcass characteristics reflected the feed intake problem, with LLH-HOG resulting in less-finished animals. These feedlot finishing factors are being further studied in a new project with J.J.McKinnon as PI which has just begun in 2006/07 and is supported by the SK ADF.

Results from the dairy, digestibility, back grounding and feedlot trials will be applied to domestic and international market development initiatives. Super Oats Canada, in cooperation with the PFRC (V. Racz), the CDC (B. Rossnagel) and STEP are developing a market development program.

Technical Report

For simplicity in reporting the Crop Development Centre (CDC) and the Prairie Feed Resources Centre (PFRC)/Animal & Poultry Science Dept. portions of the project are reported separately in this section.

Note re abbreviations: LLH = Low Acid Detergent Lignin Hull; HOG = High Oil (Fat) Groat; CDC = Crop Development Centre; PFRC = Prairie Feed Resources Centre; NZ = New Zealand; SSD = Single Seed Descent; RIL = Recombinant Inbred Line; YTs = Yield Trials.

CDC LLH-HOG prototype grain production and LLH-HOG development portion of project:

CDC Responsibility #1: ***Production and procurement of oat hull and grain samples for PFRC proof of concept trials***

2003 large scale increases for feeding trials and 2004 seed supplies:
Three F3 derived LLH-HOG selections previously identified and increased under ADF Project # 20000050 Re. 65BX were grown again in 2003 as described below. These increases, totaling some 70 acres, were used to either provide LLH-HOG grain samples for 2003/04 smaller scale proof of concept sheep and cattle feeding trials or to provide seed for planting up to 200 acres in 2004 to provide grain for the large scale 2004/2005 feedlot trial. While these increases were reasonably successful all suffered from terminal drought stress resulting in low test weight and high % thins (especially for those increases grown at Saskatoon). This did not affect utility as seed for 2004 increases but negatively affected the utility of the samples for 2003/04 feeding trials.

Friendly Acres Seed Farm, Saltcoats, SK
CDC LLH-HOG 01-499-04 – 16 acres
- pre-cleaning production = 1400 bushels (25 tonnes)
- used as seed for 2004 increases

CDC LLH-HOG 01-499-03 – 4 acres
- pre-cleaning production = 400 bushels (7 tonnes)
- used as seed for 2004 increases

Animal & Poultry Science, University Farm
CDC LLH-HOG 01-499-01 – 12 acres
- production 500 bushels (8.5 tonnes)
- used for 2003/04 feeding trials

CDC LLH-HOG 01-499-04 – 12 acres
- production 500 bushels (8.5 tonnes)
- available for 2004 feeding trials

CDC – Kernen Farm/Sutherland Farm
CDC LLH-HOG 01-499-03 – 10 acres
- this selection has approx. 10% groat fat
- cleaned production 450 bushels (8.3 tonnes)
- used as seed for increase during 2004

CDC- Bulk Increases (0.02 acre seed increases grown under irrigation at Saskatoon):
- all produced 35 – 40 kg
CDC LLH-HOG 01-499-01 TWt = 56 kg/hl, MKW = 35 g, 8.0% fat, 13.9% protein, 69% groat
CDC LLH-HOG 01-499-03 TWt = 55 kg/hl, MKW = 35 g, 10.0% fat, 16.2% protein, 69% groat
CDC LLH-HOG 01-499-04 TWt = 55 kg/hl, MKW = 30 g, 7.5% fat, 10.6% protein, 69% groat
SO02177 (advanced LLH-HOG breeding selection) TWt = 56 kg/hl, MKW = 32 g, 7.9% fat, 12.5% protein, 67% groat
SO02198 (advanced LLH-HOG breeding selection) TWt = 56 kg/hl, MKW = 38 g, 11.2% fat, 18.9% protein, 68% groat
- provided back-up seed supplies
- these also provided 200 panicles for the beginning of Breeder Seed purification for selections SO02177 (eventually became OT3012) & SO02198 (not advanced any further).

2004 large scale increases for feeding trials and 2004 seed supplies:
F3 derived LLH-HOG selections previously identified and increased under ADF Project # 20000050 Re. 65BX and increased under this project in 2003 were grown again in 2004 as described below. These increases, totaling nearly 200 acres, provided LLH-HOG grain samples for 2004/05 feedlot scale proof of concept cattle feeding trials described in the PFRC section of this report. The increases were successful in terms of yield per acre, however the 40 acre A&PS increases suffered significant hail damage just prior to harvest resulting in 25% yield loss and the 140 acre CDC increase suffered from frost and a significant late August wind and rainstorm which caused significant lodging which led to reduced grain plumpness, test weight and increased hull cohtent.

Animal & Poultry Science, University Farm
CDC LLH-HOG 01-499-04 – 50 acres
- production 4272 bushels (65 tonnes) – 25% yield loss due to late August hail storm
- used for 2004/05 Termunde Farm Processing vs Whole grain project.

CDC – Nassar Farm
CDC LLH-HOG 01-499-04 – 140+ acres
- cleaned production 17,450 bushels (269 tonnes)
- used for 2004/05 Feedlot Backgrounding Research Project and Feedlot Finishing Research Project

CDC – Special 0.5 acre increase
OT3012 – LLH-HOG 1st year WCoop entry 2004
- 643 kg cleaned seed produced
- planned used for non-pedigreed seed increase in 2005 for 2006+ market development projects assuming OT3012 was released as a variety. Since that did not occur the seed was provided to J.J.McKinnon to produce grain in 2006 for the new 2006/07 ADF feedlot evaluation project.

CDC- Bulk Increases (0.02 acre seed increases grown under irrigation at Saskatoon):
- all produced 40 – 50 kg
OT3012 (SO02177) – 2004 WCoop Oat entry, TWt = 53 kg/hl, MKW = 35 g, Plp = 92%, 8.7% groat fat, 16.3% groat protein, 71% groat

SO02174 (became SO02174 = CDC SO-I) – 2004 Rust Area Test entry, TWt = 52 kg/hl, MKW = 46 g, Plp = 98%, 7.7% groat fat, 16.3% groat protein, 72% groat
SO03774 - advanced LLH-HOG breeding selection, TWt = 53 kg/hl, MKW = 34 g, Plp = 95%, 9.6% groat fat, 15.5% groat protein, 73% groat
SO03782 - advanced LLH-HOG breeding selection, TWt = 53 kg/hl, MKW = 39 g, Plp = 95%, 9.1% groat fat, 18.0% groat protein, 70% groat
- provided back-up seed supplies
- these also provided 200 panicles for the beginning of Breeder Seed purification.
lines in 2004 WCoop Oat (including SO02174 which became CDC SO-I) and Rust Area multi-site yield trials for further Breeder Seed purification where appropriate.

2005 large scale increases for feeding trials and 2006 seed supplies:

Animal & Poultry Science, University Farm, Saskatoon
LLH-HOG ***OT3012*** – 20 acres

- using seed produced at the CDC in a 2004 special increase, 20 acres grown at A&PS Farm.
- production = 30 tonnes (approx 1700 bushels)
- used as seed for further production in 2006 for 2006/07 feedlot trials to evaluate LLH-HOG intake issues and to more fully evaluate processing effects

CDC – Special 1.5 acre increase, Kernen Crop Res Farm, Saskatoon
OT3017 (CDC SO-I) - LLH-HOG 1st year WCoop entry 2005

- 1600 kg un-cleaned seed produced
- provided to FarmPure Seeds for 2006 non-Pedigreed seed increase for market development projects.

CDC- Bulk Increases (0.02 acre seed increases grown at Kernen Crop Res Farm, Saskatoon):

- all produced 40 – 50 kg

OT3017 – 2005 WCoop Oat entry, TWt = 49 kg/hl, MKW = 44 g, Plp = 97%, 70% groat
SO02249 – 2005 Rust Area Test entry, TWt = 51 kg/hl, MKW = 32 g, Plp = 85%, 72% groat
SO04312 - adv LLH-HOG selection, TWt = 50 kg/hl, MKW = 28 g, Plp = 75%, 71% groat
SO04328 - adv LLH-HOG selection, TWt = 50 kg/hl, MKW = 38 g, Plp = 96%, 74% groat
SO04823 - adv LLH-HOG selection, TWt = 50 kg/hl, MKW = 32 g, Plp = 92%, 76% groat

- provided back-up seed supplies
- provide 200 panicles for the beginning of Breeder Seed purification and may be advanced for further Breeder Seed purification.

2006 – no large scale increases for feed grain grown under the current project

CDC- Bulk Increases (0.02 acre seed increases grown at Kernen Crop Res Farm, Saskatoon): all produced 25 – 30 kg
CDC SO-I
OT3026 (SA04975) – 1st year 2006 WCoop entry
SO04861 – 2006 RAT entry
SA051478 – white hulled LLH-HOG
SA051062 – black hulled LLH-HOG
SA02177-04 – SA02177 LLH-HOG re-selection

CDC Responsibility #2: ***Development and evaluation of oat combining LLH with HOG and high groat yield***

1: Inheritance of LLH (Mr. Shane Williams MSc project): All data collection for this activity was completed and it was determined that the LLH trait is simply inherited. Unfortunately Mr. Williams did not complete his thesis and withdrew as a graduate student at the U of S. One trait closely associated with the LLH trait (may be pleiotropic) is red/brown hull colour.

2: Screening methodology: During the course of Mr. Williams' project it became evident that the process of lignin determination using the ANKOM fibre analysis system was more labour and time consuming than anticipated and is not acceptable for routine screening in a breeding program. G. Arganosa developed a simple, relatively rapid and inexpensive hull colour staining test which is now used for regular screening for the LLH trait in the breeding program.

3: Molecular marker development for the LLH trait: A number of LLH and HLH (normal) lines were identified from the OT775 x AC Assiniboia RIL population. These were provided to G. Scoles' plant molecular biology laboratory, where BSA (bulked segregant analysis) identified a molecular marker associated with the LLH trait. The marker can be converted to a user-friendly SCAR marker for use in screening breeding program populations. As this first marker is still some distance from the LLH gene the search for a better (closer) marker continued. Unfortunately this process is not simple in oat as there is not a good consensus molecular map for oat as is the case in other crops like barley and no positive progress was made. The ability to use MMAS (molecular marker assisted selection) could improve the efficiency of breeding for the LLH trait although the simple hull colour staining technique currently serves the program well and we see no need to pursue further molecular marker development at this time.

4. Use of NIRS for LLH screening: We were unable to pursue experiments to evaluate the NIRS 6500 for utility in screening for the LLH trait.

5. Development of genotypes combining LLH with HOG and high % groat:

This report updates this section of our LLH-HOG breeding activity and includes results/activity under this section for all materials as they have progressed from the point of crossing for each of the project years 2003, 2004, 2005 and 2006.

Summer 2006 crossing block:

06 Cross #	Pedigree	Comments	# X'd seed
0624	OT3026 x OT582	LLH-HOG, e, G gr, low plp, 8% F, VG MY, smut R x yld+, attr, CRR, stg, P gr, P MY, OK BG, OK F	1
0625	OT3026 x OT3018	LLH-HOG, e, G gr, low plp, 8% F, VG MY, smut R x G yld, sht, G gr, OK MY, OK BG, low F, smut R	1
0626	SA04861 x OT3024	LLH-HOG, yld OK, , e, v stg, G gr, VG MY, > %N, brown x Pc94, yld, L, P gr, < Fat, OK MY, smut R	2
0632	CN88775 x SA04861	0.7 ADL, cream, Morocco x LLH-HOG, yld OK, , e, v stg, G gr, VG MY, > %N,	4

		brown	
0633	CN56870 x OT3026	8.2 ADL, yellow, USA x LLH-HOG, e, G gr, low plp, 8% F, VG MY, smut R	2

F1 to be grown in 2007 Saskatoon spring greenhouse.
F2 bulk to be grown at Saskatoon 2007.

Winter 2006 crossing block:

06 Cross #	06 F1 Test #	Pedigree	Comments	# X'd seed
0601	101	SA04811 x OT3018	LLH-HOG 7.5%, Yld, G gr, smut R, CRR? X e, l fat, CRR?, yld, stg, smut R	4
0602	102	*SA04861 x SO03195	LLH-HOG 8%, e, yld, stg, G+gr, smut R x yld, VG gr, smut S	1
0603	103	SO02249 x SA04213	LLH-HOG 9%, smut R, P gr x yld, VG gr, stg, smut R	5
0604	104	SO04319 x CDC Weaver	LLH-HOG 8%, stg, yld, P gr x yld, VG gr, smut R	1

F1 grown in GH at Saskatoon in summer 2006.
F2 bulks growing in 2006/07 NZ winter nursery
F3 bulk to be grown at Saskatoon 2007
* 2006/07 F2 and F3 SSD at Saskatoon for 2007 F4 SSD at Saskatoon.

Summer 2005 crossing block:

05 Cross #	06 F2 #	Pedigree	Comments
0521	201	SO02249 x SO02057	LLH-HOG 9% fat, P gr, Pc68, smut R X High yld, wk
0522	202	SO02249 x OT3018	LLH-HOG 9% fat, P gr, Pc68, smut R X VG overall, smut R, Pc68
0523	203	SO02211 x OT3019	LLH-HOG 11% fat, G gr, stg, low yld, smut S X yld, T. low TW, smut R, PC68
0524	204	SO04312 x OT576	LLH-HOG 9% fat, VG gr, smut R, Pc68 X yld, stg, P gr, smut R
0525	205	SO04312 x OT3005	LLH-HOG 9% fat, VG gr, smut R, Pc68 X Yld, MY, smut, Pc68, L, gr?
0526	206	*SA04029 x OT582	LLH-HOG 8% fat, VG gr, smut R, Pc68 X yld, stg, P gr, smut R
0528	207	*CDC SO-1 x OT3019	LLH-HOG 8% fat, stg, G gr, smut R, Pc68 X yld, T. low TW, smut R, PC68

F1grown in 2006 Saskatoon spring greenhouse.
F2 bulk grown at Saskatoon 2006.
F3 bulk being grown in 2006/07 NZ winter nursery
* 2006/07 F3 and F4 SSD at Saskatoon for 2007 F5 SSD RIL hills at Saskatoon.

Winter 2005 crossing block:

05 Cross #	06 F3 Test #	Pedigree	Comments
0501	301	SO02249 x OT3011	LLH-HOG 9% fat, P gr, Pc68, smut R X yld, CRR, smut S, VG gr, wk?

0502	302	*SO02249 x OT3013	LLH-HOG 9% fat, P gr, Pc68, smut R X yld, stg?, VG gr, G+ MY, low BG, smut R

F1 grown in GH at Saskatoon in summer 2005.
F2 grown in 2006/07 NZ winter nursery
F3 bulk grown at Saskatoon 2006.
F4 bulk growing in 2006/07 NZ winter nursery
F5 bulk to be grown at Saskatoon 2007.
* 2005/06 F2 and F3 SSD at Saskatoon for 2006 Test 499-01 F4 SSD at Saskatoon – 264 F4 single plants grown with 203 harvested and growing in 2006/07 NZ winter increase F5 hills. LLH-HOG selections to be grown as 2007 F6 MicroPlots at Saskatoon.

Summer 2004 crossing block:

04 Cross #	06 F4 #	Pedigree	Comments
0426	401	OT3012 x Jordan	LLH-HOG 9% fat, stg x yld, MY, smut, Pc68, BYDV, wk
0427	402	*SO03782 x CDC Weaver	LLH-HOG 9% fat, plp x yld, Pc68, Ex gr, MY+, smut, L
0429	403	SO03774 x OT3011	LLH-HOG 9% fat, MY x Pc68, smut

F1 grown in 2005 Saskatoon spring greenhouse.
F2 bulk grown at Saskatoon 2005
F3 bulk grown in 2005/06 NZ winter nursery
F4 bulk at Saskatoon 2006
* 2005/06 F3 and F4 SSD at Saskatoon for 2006 Test 513-01 F5 SSD RIL hills at Saskatoon – 196 hills grown with some 50% field selected. Following LLH and fat screening some 25 will be advanced to 2007 MicroPlots at Saskatoon.

Winter 2004 crossing block:

04 Cross #	06 F5 Test #	Pedigree	Comments	05 F4 SSD	06 RIL hills
0401	551	SO02291 x SO00108	LLH-HOG 9% F x vl ADF & NDF	--	
0402	552 (discard)	*SO03782 x OT7023	LLH-HOG 9% F, G qual, OK Yld x Yld, VG qual, Pc68, smut	284 grown P, T, L, v thin	06-510-01 148 grown G+, bit tall
0405	553	**SO03778 x OT2027	LLH-HOG 8% F, white? x Yld, Pc68, G gr, MY+, smut	--	06-606-01 132 grown G, seg for vvT
0406	554	**SO03747 x OT7023	LLH-HOG 12% F low yld, low plp, G MY x Yld, VG qual, Pc68, smut	--	06-606-02 200 grown F bit tall
0407	555	*SO03747 x OT399	LLH-HOG 12% F low yld, low plp, G MY x yld, VG gr, smut	268 grown F-G, shter	06-510-03 120 grown VG+

F1 grown in GH at Saskatoon in summer 2004.
F2 bulk grown in 2004/05 NZ winter nursery
2005 F3 bulk at Saskatoon
F4 bulks - 05/06 NZ winter nursery

Grown as F5 space planted bulks at Saskatoon in 2006.
* 2004/05 F2 and F3 SSD at Saskatoon for 2005 F4 SSD at Saskatoon, 2006 F5 SSD RILs at Saskatoon – with some 50% field selected. Following LLH and fat screening selections to be advanced to 2007 MicroPlots at Saskatoon.
** 2005/06 F4 and F5 SSD at Saskatoon for 2006 F6 SSD RIL hills at Saskatoon – with some 50% field selected. Following LLH and fat screening selections to be advanced to 2007 MicroPlots at Saskatoon.

Summer 2003 crossing block:

06 F5 #	03 Cross #	Pedigree	Comments	2004 F2 comments	05 SSD RILs
502-03 148 grown Poor	0330	SO02198/OT3006	LLH-HOG 11% fat x yld, MY, smut, Pc68, L, gr?	G	--
502-04 164 grown F?	0331	SO02198/OT399	LLH-HOG 11% fat x yld, Pc68, VG gr, MY+, wk, smut	G	--
502-01 144 grown VG, vT	0332	*SO02291/SO01044	LLH-HOG 9% fat x 10% fat	T, G+	05-506-01 200 grown 62 fld selected G-VG, tall
502-02 136 grown VG, black	0334	SO02256/SA02840	LLH-HOG 8% fat x black hull	VG, seg blk/br	--

F1 grown in 2003/04 NZ winter nursery or 2004 Saskatoon spring greenhouse.
F2 bulks grown at Saskatoon 2004
F3 bulks grown in 2004/05 NZ winter nursery
F4 space planted bulks at Saskatoon in 2005
F5 hills at Saskatoon in 2006
2007 MicroPlots at Saskatoon
* 2004/05 F3 & F4 SSD at Saskatoon for 2005 F5 RIL hills (05 Test 506-01) at Saskatoon with nine selections to 2006 POMPs. Best selections to 2007 Prelim YTs at Saskatoon.

Winter 2003 crossing block:

03 Cross #	06 F6 Test #	Pedigree	Comments
0301	--	SO01047 x 01-499-03-265	10% F x LLH-HOG
0302	601-03 100 grown G+	SA01987 x 01-499-04-227	12% F x LLH-HOG
0303	601-04 148 grown F at best	*SA00006 (OT3004) x 01-499-03-265	Pc68, VVG, > Fat x LLH-HOG
0304	601-01 152 grown G+, bit T, stg	*SA00006 (OT3004) x 01-499-04-227	Pc68, VVG, > Fat x LLH-HOG
0305	601-02 140 grown	SA02840 x AC Assiniboia	Black hull x LLH

	VG, some blk		
0327	--	**SO02198 X OT399	LLH-HOG brown X Yld, Pc68, VG gr, MY+, wk
0328	--	CDC Orrin x **SO02205	Yld, smut x LLH-HOG white
0329	--	**SO02205 X OT398	LLH-HOG white X Pc68, OK yld, VG gr, MY+, stg

F1 grown in field or GH at Saskatoon in summer 2003.
F2 bulks grown in 2003/04 NZ winter nursery
F3 bulk at Saskatoon 2004
F4 bulks grown in 04/05 NZ winter nursery
F5 space planted bulk at Saskatoon 2005 with single panicle selections
F6 hills at Saskatoon 2006 with selections to 2007 MicroPlots at Saskatoon
* 2003/04 F2 and F3 SSD at Saskatoon for 2004 F4 SSD at Saskatoon with 136 and 143 SSD lines harvested and grown respectively in 2004/05 NZ winter nursery as F5 RILs. LLH-HOG selections grown in 2005 Special SSD LLH-HOG Oat Microplot Prelim YT#2 at Saskatoon. After LLH selection on NZ seed, 45 and 35 planted, 9 and 8 harvested and 4 and 4 selected respectively for advance to 2006 POYTs. Best selections to 2007 SOYTs.
** not LLH

Summer 2002 crossing block:

02 Cross #	05 F5 #	Pedigree	Comments	05 notes	# to 06 POMPs
0219	501-04	SO01047 x 01-499-03-265	10% Groat Fat x LLH-HOG	150 grown G, L?	14
0221	501-01	01-499-04-227 x OT2012	LLH-HOG x yld, ss, plp, < MY	160 grown G, L?	6
0222	501-02	*01-499-04-227 x OT394	LLH-HOG x Yld, Pc68, smut?, E, plp, MY, vl TW	164 grown F?, L?	6
0223	501-03	*01-499-03-265 x OT2012	LLH-HOG x yld, ss, plp, < MY	152 grown P-F, e	16

F1 grown in 2003 spring GH at Saskatoon.
F2 bulks grown at Saskatoon 2003
F3 bulks grown in 2003/04 NZ winter nursery
F4 space planted bulk at 2004 Saskatoon
2005 F5 hills at Saskatoon with 42 selections to 2006 MicroPlots at Saskatoon.
* 2003/04 F3 & F4 SSD at Saskatoon, 2004 F5 SSD hills at Saskatoon, 05 POMPs, five selections adv to 06 POYTs as described below. Best selections to 2007 SOYTs.

02 Cross #	04 F5 SSD #	Pedigree	# F5 RILs grown/sel	04 Field Comments	05 POMPYT2
0222	508-01	*01-499-04-227 x OT394	284/55	G, T, strong?	55 grown, 20 harvested, 1 selected for adv to 06 POYTs
0223	508-02	*01-499-03-265 x OT2012	188/28	P-F at best	28 grown, 9 harvested, 4 selected for adv to 06 POYTs

Summer 2001 crossing block:

2001 Cross #	03 F4 Test #	03 F5 SSD Test #	Pedigree	Comments
0101	401	507-01	SA00406 x Furlong	>>HOG, SlowR, wk, Ggr, MY, <Plp x LLH, ss, SRR, smut, Pc68, MY+, VGgr, L
0102	402	507-02	SA00406 x SA00657	>>HOG, SlowR, wk, Ggr, MY, <Plp x LLH, Yld, <TW, MY+, smut, Pc48
0103	403	507-03	SA00489 x OT2009	>HOG, MY+, CRR, VGgr x LLH, ss, SRR, smut, Pc68, MY+, VGgr. Late
0104	429		SA00489 x SA00657	>HOG, MY+, CRR, VGgr x LLH, Yld, <TW, MY+, smut, Pc48
0105	404		Furlong x SA00523	>HOG, Yld, VGgr, MY, %N, CRR, smut` x LLH, ss, SRR, smut, Pc68, MY+, VGgr., L
0106	405		SA00523 x SA00657	>HOG, Yld, VGgr, MY, %N, CRR, smut` x LLH, Yld, <TW, MY+, smut, Pc48
0107	406		Furlong x OT395	Pc48, >HOG, smut, need plp x LLH, ss, SRR, smut, Pc68, MY+, VGgr. Late

F1 grown in 2001/02 NZ winter nursery or in Saskatoon greenhouses.
F2 bulk grown at Saskatoon in 2002
F3 bulks in 2002/03 NZ winter nursery
2003 F4 space planted bulks at Saskatoon
2004 F5 hills at Saskatoon
2005 POMPYTs at Saskatoon.
2006 POYTS at Saskatoon and KCRF
Crosses 0101, 0102 and 0103 processed through F3 and F4 SSD in 2002/03 phytotron and greenhouses with F5 SSD hills grown at Saskatoon in 2003 for 2004 F6 YT or 4x hills adv to 2005 SOYTs, POYTs or MicroPlot YTs., with 2006 testing at WCoop, RAT, SOYT or POYT level.

LLH-HOG selection* SA04975 *advanced to the 2006 WCoop trials as OT3026. While only preliminary WCoop data is available at the time of writing this report OT3026 performed reasonably well across western Canada and has much improved % groat vs CDC SO-I.

LLH-HOG selections* SA04861 & SA04811 *advanced to the 2006 Rust Area test. No data is available from that 2006 trial at the time of writing this report.

2001 Cross #	03 F5 SSD Test #	Pedigree	# Hills grown	# Field Selected	# LLH	# Seg LLH	# Normal
0101	507-01	SA00406 x Furlong	232	93	46	6	41
0102	507-02	SA00406 x SA00657	228	76	43	2	31
0103	507-03	SA00489 x OT2009	168	82	50	1	31

15, 12 and 8 F6 lines respectively advanced to 2004 PrelimYTs at Saskatoon with 3, 2 and 2 selections advanced to 2005 multi-site SOYTs with 2006 testing at WCoop, RAT, SOYT or POYT level.

16, 26 and 16 F6 lines respectively advanced to 2004 4x hill trials at Saskatoon with 3, 5 and 2 advanced to 2005 POYTs at Saskatoon with surviving selections to 2006 SOYTs.

Selections SA04800 and SA04876 advanced to 2006 SOYT#1. Selections SA04367, SA04377 and SA04840 advanced to 2006 SOYT#2. Results from these trials indicate that SA04876 is worthy of advance to the 2007 RAT or WCoop trials as it shows good yield combined with very strong straw and very good physical grain quality.

F5 hills at Saskatoon 2004.

2001 Cross #	04 F5 Test #	# F5 Hills grown	Pedigree	2004 Field Comments	05 POMPYTs Grown/Harvest/Select
0101	501-01	156	SA00406 x Furlong	G+, stg, e	13/7/4
0102	501-02	152	SA00406 x SA00657	VG, nice ss seg, e	13/10/6
0103	501-03	148	SA00489 x Furlong	G, not quite as stg but lots G+, def br hulls	6/0/0
0104	501-07	156	SA00489 x SA00657	VG+, stg, nice ht seg	19/9/6
0105	501-04	156	Furlong x SA00523	VVG, stg, some shorter	9/6/2
0106	501-05	148	SA00523 x SA00657	G-VG, stg, e	11/9/7
0107	501-06	136	Furlong x OT395	G+	2/0/0

Approximately 50% selected in field 2004 followed by screening for LLH. Remaining 73 selections grown in 2005 Microplot Prelims at Saskatoon with 41 field selected and 11 advanced to 2006 POYTs.

Winter 2001 crossing block:

LLH-HOG 3 way crosses:	Comments	# 02/03 NZ F5 hills	# RILs in 03 LLH-HOGYT 4 & LLH seg	# RILs in 03 4x hills Test 908	04 POYT#5
(AC Assiniboia x OT386 F1) X SA96121*	(LLH x CRR, yld+) X HOG, %N	105	2	11 2 / 1 / 8	1 adv to 05 SOYT
(Wpg96Prel17 x AC Assiniboia F1) X CDC Dancer	(LLH x HOG) X smut, MY	NA	NA	NA	--
(AC Assiniboia x OT386 F1) X IA9108-24	(LLH x CRR, yld+) X HOG	NA	NA	NA	--
(CDC Dancer x IA91098-2 F1) X AC Assiniboia*	(HOG x MY) X LLH	169	23	34 21 / 1 / 12	3 adv to 05 SOYT
(SA97404 x SA97496 F1) X AC Assiniboia*	(HOG fat x high fat) X LLH	124	5	15 7 / 4 / 4	2 adv to 05 SOYT

F1 grown at Saskatoon summer 2001.
F2 bulks grown in 2001/02 NZ winter nursery.
F3 bulks grown at Saskatoon in 2002.
F4 bulks grown in 2002/2003 NZ winter nursery.
F5 space planted bulks grown at Saskatoon 2003.
2004 F6 hills at Saskatoon with 30 selections adv to 05 POMPs.
Best selections advanced to 2006 SOYTs.
Three crosses marked * advanced via single seed descent (SSD) through the F2 and F3 generations in Saskatoon greenhouses during the 01/02 winter with F4 SSD generation grown at Saskatoon during 2002 with F5 RIL hills grown in NZ 02/03 winter nursery. 30 selected F6

RILs grown as unrep yield plots at Saskatoon as 2003 LLH-HOGYT 4, and 72 RILs grown as Test 908 4x hills at Saskatoon 2003.
3 and 4 LLH-HOG selections from 2003 LLH-HOGYT 4 advanced to 2004 multi-site SOYT #2 and SOYT #4 respectively. None adv for further testing.
19 LLH-HOG selections from 2003 T-908 4x hills advanced to 2004 PrelimYTs at Saskatoon with 6 selections to 05 SOYTs with SO04328 re-tested in 2006 POYT# 10 and SO04319 re-tested in 2006 SOYT# 2.

2004 F6 hills at Saskatoon.

LLH-HOG 3 way crosses:	# 04 F6 hills Test #	# grown	2004 Field comments	2005 POMPs Grown/Harvested	# to 06 POYTs
(AC Assiniboia x OT386 F1) X SA96121*	601-01	152	G+, T, stg	15/8	3
(Wpg96Prel17 x AC Assiniboia F1) X CDC Dancer	601-02	152	G+, T	0/0	0
(AC Assiniboia x OT386 F1) X IA9108-24	601-03	144	G	2/0	0
(CDC Dancer x IA91098-2 F1) X AC Assiniboia*	601-04	144	G?, stg	24/10	2
(SA97404 x SA97496 F1) X AC Assiniboia*	601-05	156	F-G?, wk?	10/0	2

Approximately 50% selected in field 2004 followed by screening for LLH. Remaining 51 selections grown in 2005 Microplot Prelims at Saskatoon with 7 advanced to 2006 POYTs.

Summer 2000 crossing block:

LLH crosses:	Comments	02 F5 Adv to 03 YT& 4x hills	# of 02 F5 RIL hills	# 03 F5 Hills	LLH seg
SA96121 x AC Assiniboia	high fat, %N x LLH	0	0	156	0 / 2 / 22
AC Assiniboia x OT386	LLH x CRR, yld+, ss	0	0	152	24 / 6 / 35
*AC Assiniboia x IA91098-2-4	LLH x very high fat	17 + 36	212	75	37 / 9 / 14

F1 grown in 2000/01 NZ winter nursery.
F2 bulks grown in Saskatoon during summer 2001, F3 bulks grown in the 01/02 NZ winter nursery, F4 space planted bulks grown at Saskatoon 2002, F5 hills grown at Saskatoon 2003 – Tests 501-01, 02 and 03 (no selections advanced from 501-03).
5 and 9 LLH-HOG selections from 2003 T-501-01 and 02 respectively advanced to 2004 PrelimYTs at Saskatoon with 7 adv to 2005 SOYTs
3 and 10 LLH-HOG selections from 2003 T-501-01 and 02 respectively advanced to 2004 4x hill trials at Saskatoon with 2 adv to 2005 POYTs.
The cross marked * above was advanced through the F3 and F4 generations via SSD in greenhouses at Saskatoon during the 01/02 winter with resulting F5 SSD hills grown at Saskatoon during 2002 with F6 RIL yield plots grown at Saskatoon in 2003.
17 LLH-HOG selections grown in 2003 POYT#16

- 3 selections advanced to 2004 SOYT#3 (none advanced to further testing)

36 LLH-HOG selections advanced to 2003 4x hill trials

- 5 selections advanced to 2004 POYT#1 & 2 (2 reps x 2 sites) with 1 adv to 2005 SOYTs (none advanced to further testing)
- 8 selections advanced to 2004 POYT#7 (1 rep x 1 site) – none adv.

Winter 2000 crossing block:

LLH crosses:	Comments	03 F6 Test #	# 03 LLH-HOG SOYT entries	# 03 LLH-HOGYT entries	# 03 F6 Hills	LLH seg
AC Assiniboia x SA96121*	Pc68, LLH x high fat	601-01	2	11	152	16 / 1 / 15
Wpg 96 Prel 17 x AC Assiniboia	Pc68, LLH x high fat	601-02	0	0	151	22 / 1 / 12
AC Assiniboia x LAC 505-001*	Pc68, LLH x high fat	601-03	2	17	152	14 / 0 / 10
96Mn22309 x AC Assiniboia*	Pc68, LLH x high fat	601-04	0	11	161	18 / 0 / 19
SA98110(OT387) x AC Assiniboia	Pc68, LLH x high fat	601-05	0	0	65	5 / 1 / 8
Triple Crown x AC Assiniboia	Pc68, LLH x HLH	601-06	0	0	81	9 / 1 / 9

F1 grown at Saskatoon during summer 2000.
F2 bulks grown in 2000/01 NZ winter nursery, F3 bulks grown at Saskatoon during summer 2000, F4 bulks grown in 01/02 NZ winter nursery, F5 space planted bulks grown at Saskatoon in 2002, F6 hills grown at Saskatoon 2003.
5, 7 and 4 LLH-HOG selections from 2003 T-601-02, 03 and 04 advanced to 2004 PrelimYTs at Saskatoon, 3 adv to 2005 SOYTs (none advanced to further testing)
7 and 8 LLH-HOG selections from 2003 T-601-01 and 04 advanced to 2004 4x hills at Saskatoon, 1 adv to 2005 SOYTs (none advanced to further testing).

F2 and F3 SSD (Single Seed Descent) generations of three crosses marked * above were grown in the 2000/2001 winter SSD program in the Phytotron/greenhouse at Saskatoon. During the summer of 2001 field planted populations of F4 SSD lines from each cross were grown under irrigation (AC Ass x SA96121 - 204 lines; Wpg 96 Prel 17 x AC Ass - 222 lines; AS Ass x LAC 505-001 - 234 lines; 96Mn22309 x AC Ass - 242 lines). Resulting single plants gave enough seed to test for groat fat in Sept. 2001. That data was used to select F4 derived HOG lines (100 each from crosses AC Assiniboia x SA96121, AC Assiniboia x LAC505-001 and 96Mn22309 x AC Assiniboia) which were grown in the 01/02 NZ winter nursery as 2m F5 rows. These lines were segregating for the LLH trait. The spring 2002 harvested F5 NZ rows were tested for fat on their return from NZ with F6 LLH-HOG selections grown in Prelim YT's in 2002. All 71 putative LLH-HOG entries from 2002 LLH-HOGSSDYT#'s 1 – 4 were sent to the 2002/03 NZ winter nursery for seed increase. Selected LLH-HOG lines following complete quality analysis were advanced to multiple site YTs during 2003.

These trials included the 16 entry (11 LLH-HOG selections + 5 checks) 3 rep trial 2003 LLH-HOGYT 1 grown at 5 sites (Saskatoon, Goodale, KCRF, Wakaw and Canora); the 30 entry (26 LLH-HOG selections + 4 checks) 3 rep trial 2003 LLH-HOGYT 2 grown at 2 sites (KCRF &

Wakaw); the unreplicated 36 entry (28 putative LLH-HOG selections + 8 checks) 2003 LLH-HOGYT 3 grown at KCRF and 4 selections in the 6 site 2003 SOYT# 2.

In 2003 SOYT# 2 lines SO02174 (became OT3012) and S002177 (became OT3017 = CDC SO-I) from the cross AC Assiniboia x SA96121 yielded similar to CDC Dancer with acceptable grain quality and 8.3% and 9.0% fat respectively vs checks at 5 – 6.5% fat. SO02198 and SO02219 from the cross AC Assiniboia had higher % fat at 11.2 and 9.6% respectively and good % groat but smaller grain size and considerably lower yield.

SO02177 was advanced to the 2004 WCoop Oat trial as OT3012. It was noted as being strong strawed in the trials and had good groat percentage and grain plumpness but preliminary yield data indicate it was considerably lower yielding than desired, thus it was dropped from Coop testing.

SO02174 was advanced to the 2004 Rust Area trial. As it showed better yield and otherwise similar quality it was advanced to the 2005 WCoop as OT3017 effectively as a replacement for OT3012). OT3017 was supported for registration by the PRRCG in February 2006 (please see request for registration support documentation attached) and was registered as CDC SO-I, the first LLH-HOG variety in Canada, on July 25, 2006.

SO02249, selected from the cross 96Mn22309 x AC Assiniboia, was advanced to the 2005 Rust Area Test. However with the support for registration of CDC SO-I it was dropped from further testing.

In anticipation of the possible release of OT3012 or SO02174 (OT3017) as the first LLH-HOG variety, to speed Breeder Seed production and eventual commercialization, 100 Breeder Seed hills of each were grown in the 2004/05 NZ winter nursery. After checking each returning Breeder Line for the LLH trait and % fat, seed from these NZ Breeder Hills was used to plant Breeder Long Row increases at the Kernen Crop Res Farm in 2005. As the decision was made to drop it from further testing the Breeder rows of OT3012 were discarded. After careful rogueing to remove off-type rows some 400 kg of first Breeder Seed of OT3017 was produced from a bulk of 83 Breeder lines. This Breeder Seed was cleaned and stored for release to FarmPure Seeds for Select Seed production in 2006.

2006 CDC SO-I Breeder Seed increase at KCRF – 1 acre increase with 1800 kg produced with 99 % germination.

b) Progress re HOG related to SuperOat Project:

In addition to our LLH-HOG work we continued development of very high groat fat normal hulled materials for possible use in the weaner pig feed market where very high energy density feed is required. As a result of these efforts and by using SSD and NZ winter nurseries to speed the process we had a number of lines with 9 - 14% groat fat in Yield Trials at Saskatoon in 2001 through 2006.

These lines have and will be utilized in the next series of LLH-HOG crosses to attempt to further boost the energy levels of the LLH-HOG project derivatives and to also provide LLH-HOG derivatives with a potential alternative high fat groat market with a more marketable hull by-product.

Attached 2006 SOYT and POYT data files for LLH-HOG selections – *five entries in 2006 SOYT #'s 1 & 2 and 57 entries in 2006 POY #'s 1, 2, 3 & 10.*

PFRC proof-of-concept portion of project:

Evaluation and Feeding Studies with Low Lignin-High Oil Oat Grain

J.J. McKinnon, V.J. Racz, D.A.Christensen, L. Fuhr (MSc candidate) and G. Zalinko (MSc candidate), Dept. of Animal and Poultry Science and PFRC, U of S

This portion of the LLH-HOG project had as its objectives:

a) To determine in vitro/in situ digestibility (IVDMD & ISDMD) of LLH-HOG oat and its constituent behavior to allow modeling of diet formulation to maximize LLH-HOG value

b) Using the sheep and cattle models, evaluate feed intake and energy digestibility of LLH-HOG oat

c) Determine the LLH-HOG oat value relative to conventional oat and barley in dairy production and beef feedlot (backgrounding and finishing) trials.

In previous work, varieties of oat grain were identified with low acid detergent lignin hull (LLH) and others with high oil groat (HOG). Through chemical analysis and *in vitro* and *in vivo* nutrient studies the potential feeding value of an LLH-HOG oat was predicted and simulated by computer modeling. Steer digestibility trials with high (normal) and low lignin hulls (LLH) were used to evaluate the differences and real expected increase in energy with LLH-HOG grain. Results showed that LLH oat had increased fibre digestibility and thus more energy as compared to regular oat with normal hull lignin. From animal response and nutrient behavior, assuming 27 to 28% dry matter of oat grain being hull, a 6.5 to 7.5 unit increase in total digestible nutrients could be expected The added energy value from increased hull digestibility would make LLH oat equal in energy to barley. The addition of higher fat (HOG) would further increase energy values by approximately 1.0 unit of net TDN for every 1% increase in fat. However, ruminants can only tolerate certain diet fat levels as excess fat in the overall diet will reduce feed intake and fibre digestibility. Since this effect can be overcome by limiting the fat amount in the diet, the maximum increased oat groat fat was of concern and was considered in the target groat fat levels of the breeding program.

Final Report to Agricultural Development Fund, December 2006; Super Oat Project Market Development and Commercialization Activities.

By: Vernon J. Racz, Research Scientist; Dept of Animal and poultry Science

The proof of concept for developing a high value feed oat led to the development of dairy feeding and beef feedlot evaluations. The project then moved to evaluations with animals and aspects that support marketing such as processing effects and nutritional characterization. McKinnon, Racz, Christensen and Rossnagel have a resulting ADF funded project to study the feed intake problems at high oat levels and to look at appropriate inclusion rates in ruminant diets to maximize value.

Dairy and Beef Feeding trial results: The dairy feeding trial conducted by MSc student Leland Fuhr as supervised by D.A.Christensen has been completed and he has successfully defended his MSc. thesis. Results of the dairy evaluation portion are attached as extracted from Mr. Fuhr's thesis. Similarly the beef feeding trials conducted by MSc student Grant Zalinko under the supervision of J.J.McKinnon have been completed. Mr. Zalinko should defend his thesis early in 2007. Please see attached report for the results of this beef feeding evaluation.

The following are highlights pertinent to planned market development and commercialization activities:

The dairy feeding trial showed increased milk yield from feeding LLH-HOG oat. While actual levels of oat used in practice would not be at these high levels, the results show the enhanced utility of LLH-HOG oat. The in situ nylon bag work evaluating rumen disappearance rates showed the LLH-HOG oat to have the behaviour where a larger portion of the carbohydrate fraction was similar to digestible forage rather than the indigestible hull of normal lignin hull oat. This was one of the original intents in the development of LLH-HOG oat. When feeding graded levels of LLH-HOG oat to sheep in comparison to graded levels of barley, results indicated energy values of the LLH-HOG oat to be higher or at least equal to that of barley.

The dairy feeding trial demonstrated a good response in practical dairy feeding situations. In those areas where forage is in deficit, LLH-HOG oat has a natural fit as highly digestible fibre in high producing dairy rations. Domestically, in barley based dairy diets, LLH-HOG oat would add fibre for improved cow health and increased production providing an added benefit and value beyond that normally available from normal lignin hull normal groat fat oat.

Feedlot and digestibility trials: The data from the digestibility trials did not show equal digestibility versus barley and in some cases, particularly at higher LLH-HOG oat levels in the diet, digestibility was lower for the LLH-HOG oat.

The feedlot back grounding trial showed a significant positive response versus barley for LLH-HOG oat for both gain and feed efficiency. In a second smaller back grounding study at the Termuende Farm at Lanigan, SK, no effect of processing (rolling) LLH-HOG oat versus feeding the LLH-HOG oat as whole grain was detected. This is an area of interest that must be pursued and verified since elimination of the need to process grain used for feed offers significant economic benefit to cattle producers.

The large scale feedlot finishing study, comparing corn, barley, and LLH-HOG oat in a finishing diet indicated significantly poorer performance for the LLH-HOG oat. Dry matter intake for the LLH-HOG oat diet was significantly lower resulting in extended time to market readiness of the cattle. Processing effects were a possible explanation for the lower feed intake, but it was most likely a result of excess unsaturated fat in the diet. Carcass characteristics reflected the problem with feed intake, resulting in less fat animals.

At the last Super Oats Canada Ltd., Board of Directors meeting on September 19, 2006 the Board reviewed data from all completed feeding trials and crop breeding activities. On this basis, and with the registration of the new LLH-HOG oat variety CDC SO-I, they agreed to proceed with the development of step two of their technology based market development and commercialization program. These market development activities include the participation of

the Prairie Feed Resource Centre and CDC. The market development project has 3 phases. Super Oats Canada has developed strategic alliances with FarmPure Seeds, the Prairie Feed Resource Centre and S.T.E.P. to carry forward the market development and commercialization program. An application was made to the ACAAFS program in May 2005 outlining the three phases. Approval for 50% funding was given to Phase I. Phase II and Phase III were approved dependent on a variety being moved into commercialization. This has been done and phase two has been initiated.

The schedule and amount allocated for each phase by Super Oat is as follows:

Phase I: Initial market development to determine target markets and development of technical market information to provide for the marketing of a Super Oat ($18,000)

Phase II: Targeted marketing initiatives in selected markets ($60,000)

Phase III: Ramp up of targeted marketing initiatives to support and accompany commercial activities ($200,000)

A portion of Phase I is tied to the development of technical information to answer specific concerns. Monetary support for research on and development of technical information is being provided to an ADF project (PI McKinnon with CIs Racz, Rossnagel, and Christensen) to address these concerns. The aspects of feed intake reduction with high LLH-HOG levels in feedlot diets and reasons for such are being evaluated. The prospect of feeding whole oat without processing would have significant advantage and feed saving, as would post-harvest processing such as clipping to increase density for transport efficiency and enhanced product quality (especially for overseas markets). These are all questions and problems that need resolution and will be carried forward to support commercialization activities.

The last Super Oats Canada Board meeting mapped out a strategy for targeted market development and associated activities. The basis for this program arises from technical data, modelling the fit of LLH-HOG oat into different markets based on past experience and which will allow the best return from an integrated IP system.

In summary Super Oats Canada is pleased with results to date and have commended those involved who have taken this full value chain approach to innovation. It is a unique approach and in the words of Super Oats Canada Chairman, Trenton Baisley, "The project produced and exceeded expectations."

Acknowledgement - the ADF contribution was recognized each time reports were developed for Super Oats Canada Ltd. and each time the project was noted during various oat extension events and media opportunities including annual POGA conferences, annual CDC oat R&D project summer field tours, at the 2004 Int'l Oat Conference in Helsinki and at the AOWC in North Carolina.

A University of Saskatchewan press release re the registration and release of CDC SO-I was jointly developed by the CDC, SuperOats Canada Ltd., FarmPure Seeds and SDA&F in November 2006. This item included a quote from the Minister. A copy is attached to this report.

The Effect of a Low Lignin Hull, High Energy Oat on Performance and Carcass Characteristics of Growing & Finishing Cattle

Final Report
To
The Saskatchewan Agriculture Development Fund

Prepared By:

Grant Zalinko, M.Sc. candidate
In conjunction with
J. McKinnon & V. Racz
Department of Animal & Poultry Science
University of Saskatchewan

October, 2006

1.0 Introduction

Inclusion of cereal grains in feedlot cattle diets increases dietary energy density, improves animal performance, improves feed efficiency and produces desirable carcass characteristics. As concentrated sources of energy, cereal grains can be transported to feedlots more economically than forages and can reduce the cost of gain. Feed grain selection for cattle feeding is dependent on several factors. Economically, cost per unit of energy is an important determinant for feed grain selection. Agronomically, local growing conditions influence the availability of feed grain. In the United States, corn is the predominant grain source in finishing diets (Kincheloe et al., 2003). With excellent animal performance and a minimum of digestive disorders, the use of corn in feedlot cattle diets in the United States is well accepted (Gray and Stallknecht 1988). The reported energy value of corn (56 lb/bu) is NE_m 2.18 Mcal/kg and NE_g 1.50 Mcal/kg (NRC, 1996). In western Canada, barley is the primary cereal grain used in feedlot cattle diets. The reported energy value of heavy barley grain is NE_m 2.06 Mcal/kg and NE_g 1.40 Mcal/kg (NRC, 1996). Lower starch content and higher hull content in barley grain may account for the lower energy value relative to corn. To a lesser extent, oat grain has been utilized in feedlot cattle diets. The reported energy value of oats (38 lb/bu) is NE_m 1.85 Mcal/kg and NE_g 1.22 Mcal/kg (NRC, 1996). Digestible energy value of oats is lower primarily due to the high percentage of hull. The hull of the oat can constitute up to 25% of the total weight of the oat grain and is high in lignified fibre, accounting for lower digestibility and poorer nutritional value (Thompson et al. 2000). Reducing the lignin content of the oat hull may increase the digestible energy of oat grain. Compared to barley and corn, oat grain has higher oil content and may be beneficial in high concentrate feeding programs. Replacing carbohydrates with lipids increases the energy concentration of feedlot diets and may reduce acidosis in feedlot cattle. Ingestion of excessive

amounts of readily fermentable carbohydrates can increase the incidence of acute and chronic acidosis in feedlot cattle (Owens et al. 1998). The digestible energy of oat grain may be increased through selective breeding of an oat cultivar that combines a low lignin hull with a high oil groat. Diets of beef calves including high fat oats (9-10% DM basis) have shown to be well utilized by ruminants with some indication of improved feed efficiency (Devlin et al. 1977).

The development of a low lignin hull, high energy oat (LLH-HOG) is a project supported by the Saskatchewan Agriculture Development Fund, Super Oats Canada Ltd., the Crop Development Centre and the Prairie Feed Resources Centre, University of Saskatchewan. The Crop Development Centre at the University of Saskatchewan has successfully developed an oat that combines a low lignin hull (1.5 % DM) and high oil groat (8.5-9.0% DM) (Racz and Rossnagel 2004).

The development of a low lignin hull, high-energy oat (LLH-HOG) is a project supported by the Saskatchewan Agriculture Development Fund, Super Oats Canada Ltd., the Crop Development Centre and the Prairie Feed Resources Centre, University of Saskatchewan. The Crop Development Centre has successfully developed an oat variety that combines a low lignin hull (1.5 % DM) and high oil groat (8.5-9.0% DM) (Racz and Rossnagel 2004). The objective of this phase of the project was to evaluate the performance of cattle fed the LLH-HOG oat as an energy source in both backgrounding and finishing diets as well as the effects on carcass quality.

2.0 Feedlot Backgrounding Study

2.1 Study Design

Four hundred crossbred beef steers purchased from local auction markets in November 2004 were transported to the Beef Cattle Research Unit near the University of Saskatchewan,

Saskatoon, SK. At arrival, cattle were ear tagged, vaccinated against infectious bovine rhinotracheitis (IBR), parainfluenza 3 (PI3), bovine viral diarrhea (BVD), bovine respiratory syncytial virus (BRSV) (Star Vac®, Novartis Animal Health Canada Inc., Missisauga, ON); Haemophilus somnus and Pasteurella haemolytica (Somnu-Star Ph®, Novartis Animal Health Canada Inc., Missisauga, ON); clostridial diseases (Covexin® 8, Schering-Plough Animal Health, Schering Canada, Point-Claire, PQ), implanted (Synovex S®, Wyeth Animal Health, Guelph, ON) and treated for parasites (Ivomec®, Merial Canada, Boie D'Urfe', PQ). Cattle were fed processed grass hay for the first three days following arrival and then switched to a backgrounding diet consisting of 50% barley silage, 20% grass hay, 5% supplement pellets and 25% barley grain (as fed basis) until the experiment started.

The 98-day backgrounding performance trial started December 1, 2004 and ended on March 8, 2005. Steers were weighed in the morning on the two consecutive days prior to the start of the trial and an average weight was calculated to determine initial weight. Ultrasound measurements for rib-eye area and backfat thickness were taken at the start of test. Steers (275.4 kg ± 68.1 kg) were assigned by weight to one of 12 pens (33 or 34 head per pen, average initial pen weight 275.4 kg ± 0.9 kg) and one of two dietary treatments in a randomized complete block design to determine the effect of grain source on cattle performance and ultrasound carcass measurements. The pen was the experimental unit. Steers were kept outside in pens with an open faced shed, windbreak fencing, automatic water bowls and a concrete feed bunk. Steers were weighed bi-weekly unshrunk prior to the morning feeding. At the end of the test, steers were weighed unshrunk on two consecutive days and an average weight was calculated to determine final weight. Ultrasound measurements for rib-eye area and backfat thickness were taken at the end of test.

Following the weighing on day 43 of test, the energy concentration of the diets was reduced to adjust ADG closer to the target gain of 1.0 kg/d. Data collected during the backgrounding performance trial was used to measure the following performance parameters: weight gain, average daily gain, dry matter intake, and feed efficiency. Data collected from the backgrounding performance trial was analyzed as randomized complete block design. Statistical analysis was performed using the Proc Mixed procedure of the SAS Institute, Inc. (1998). Dietary treatment (barley or LLH-HOG) was the fixed effect and the block was the random effect. Pen average was the experimental unit. The degree of freedom for means was determined using the Kenward-Roger option. Pen averages were calculated and Fisher's Least Significant Difference test was used to test the means comparison for significance. Significance was declared at $p \leq 0.05$.

2.2 Results & Discussion

Results from the backgrounding performance trial are presented in Tables 2.2 and 2.3. Average daily gain of the cattle during the 98 day backgrounding trial averaged 1.28 and 1.23 kg/d for the oat and barley fed cattle, respectively. Dry matter intakes were lower ($P<0.05$) for the oat-fed cattle (7.49 vs. 7.72 kg/d), consequently the oat-fed cattle were more ($P<0.01$) efficient (gain to feed ratios 0.171 vs. 0.159). Average fat content of the oat diet was 6.15% of diet DM and should not have been excessive to contribute negatively to the lower DMI of the oat-fed cattle. Lower DMI of the oat-fed cattle likely resulted from higher NDF in oat diet (44.9% diet DM vs. 40.3% NDF in barley diet). Ultrasonic live animal

carcass measurements indicated that the oat-fed cattle had larger ribeyes ($P<0.03$) at the end of backgrounding with no difference in backfat measurements.

The objectives of backgrounding cattle are to promote lean tissue growth yet control the rate of gain and do so in an efficient and economical manner. The results of this study indicate that the feed value of LLH-HOG oat is at least equal to barley in growing diets for beef cattle. In fact when one looks at the efficiency of gain (i.e. equal gain on less feed) and lean tissue growth (i.e. ribeye area), the results of this study would indicate that the LLH-HOG oat is superior to barley.

Table 2.1 Ingredient and formulated nutrient composition of backgrounding diets

Ingredient	Day 1-43		Day 43-98	
	Barley	LLH-HOG	Barley	LLH-HOG
Barley silage	23.66	23.67	20.22	20.22
Barley grain	41.48	0.28	39.38	0.26
LLH-HOG grain	-	38.80	-	36.83
Grass hay	29.80	29.81	28.29	28.30
Barley straw	-	-	7.32	7.32
Canola meal	2.45	4.91	2.32	4.65
Calcium carbonate	0.85	0.77	0.81	0.73
Trace mineral salt[a]	0.43	0.43	0.41	0.41
Vitamin premix[b]	0.68	0.68	0.64	0.64
Vitamin E premix[c]	0.008	0.008	0.008	0.008
Monensin sodium premix[d]	0.38	0.38	0.36	0.36
Tallow	0.27	0.27	0.26	0.26
Formulated nutrient profile				
DM %	57.1	57.0	60.1	60.1
CP %	12.5	12.5	12.0	12.0
TDN %	66.3	66.1	64.7	64.6
DE (mcal/kg)	2.9	2.9	2.8	2.8
NEm (mcal/kg)	1.52	1.51	1.46	1.46
NEg (mcal/kg)	0.92	0.92	0.88	0.87
Ca %	0.56	0.57	0.55	0.56
P %	0.31	0.32	0.31	0.32

a Sodium 36.5%, Salt 91.5%, Zinc 12,000 mg/kg, Manganese 10,000 mg/kg, Copper 4,000 mg/kg, Selenium 120 mg/kg, Iodine 200 mg/kg, Cobalt 60 mg/kg.
b Vitamin A 10,000,000 IU/kg, Vitamin D_3 1,000,000 IU/kg, Vitamin E 10,000 IU/kg.
c Vitamin E 500,000 IU/kg
d Monensin sodium 5,000 mg/kg

Table 2.2 Backgrounding performance trial summary

	Diet			
Parameter	Oat	Barley	SEM	P value
Liveweight				
Initial (kg)	275.4	275.4	0.21	1.00
Day 43 (kg)	337.7*a*	333.6*b*	0.98	0.01
Final (kg)	400.8	395.6	2.21	0.13
Day 1-43				
Gain (kg)	62.3*a*	58.2*b*	1.30	0.02
DMI (kg/d)	7.57*a*	7.80*b*	0.05	0.01
ADG (kg/d)	1.48*a*	1.38*b*	0.02	0.02
Gain:Feed	0.196*a*	0.178*b*	0.002	<0.01
Intake [z] (%)	2.40*a*	2.49*b*	0.01	<0.01
Day 43-EOT				
Gain (kg)	63.1	62.1	1.54	0.63
DMI (kg/d)	7.43*a*	7.67*b*	0.07	0.04
ADG (kg/d)	1.13	1.11	0.03	0.63
Feed:Gain	6.60	6.94	0.03	0.06
Gain:Feed	0.152	0.144	0.002	0.06
Intake [z] (%)	1.97*a*	2.06*b*	0.01	<0.01
Overall				
Gain (kg)	125.4	120.2	2.18	0.12
DMI (kg/d)	7.49*a*	7.72*b*	0.06	0.02
ADG (kg/d)	1.28	1.23	0.02	0.12
Gain:Feed	0.171*a*	0.159*b*	0.002	<0.01
Intake [z] (%)	2.16*a*	2.25*b*	0.01	<0.01

a,b Means followed by a different letter are significantly different (P≤0.05).
z Intake expressed as average dry matter intake/average body weight for period.

Table 2.3 Ultrasound measurements

	Diet			
Parameter	Oat	Barley	SEM	P value
Initial Backfat Depth (mm)	1.52	1.52	0.04	1.00
Final Backfat Depth (mm)	2.75	2.72	0.13	0.86
Initial Ribeye area (cm^2)	51.64	51.61	0.32	0.94
Final Ribeye area (cm^2)	65.43*a*	63.81*b*	0.46	0.03

a,b Means followed by a different letter are significantly different (P≤0.05).

3.0 Effect of Processing LLH-HOG Oat on Backgrounding Performance of Cattle

3.1 Study Design

One hundred and twenty-four crossbred calves were sorted by sex and weight and assigned to one of four pens in a randomized complete block design in mid November 2004. The steers were weighed in the morning on two consecutive days and an average weight was calculated to determine initial weight. The calves were fed one of two diets consisting of whole or dry-rolled LLH-HOG to determine the effect of processing on performance of backgrounding calves. Forages consisted of barley straw, grass hay and barley greenfeed. All forages were processed prior to mixing with the LLH-HOG and mineral/vitamin supplement. The diets were:

a. 35% dry rolled LLH-HOG, 32.5% grass hay, 32.5% greenfeed, mineral/vitamin premix;

b. 35% whole LLH-HOG, 32.5% grass hay, greenfeed, mineral/vitamin premix.

Data collected during the processing trial was used to measure the following performance parameters: weight gain, average daily gain, dry matter intake and feed efficiency.

3.2 Results & Discussion

Table 3.1 provides a summary of the processing trial. As in trial one, cattle fed LLH-HOG oat based diets performed at levels expected for growing cattle (~1.0 kg/d). There was no difference in average daily between cattle fed the whole vs. the rolled LLH-HOG oat (0.94 vs. 0.97 kg/d). Gain to feed ratios were 0.125 vs. .135 for the whole vs. the rolled oat fed cattle. Dry matter intakes were not significantly different between the 2 treatments. The results of this study would indicate that at levels used in this trial, the LLH-HOG oat when fed whole are is as

digestible as when fed dry rolled. Presumably, the low-lignin nature of the hull is responsible for this observation. This result is an extremely important finding for the cattle industry. Processing cereal grains either by rolling or grinding is a significant cost. Estimates range from $5 to $15 per tonne, based on method and size of operation. If as indicated in this study, that the LLH-HOG oat can be fed whole to growing cattle with no loss in performance, significant economic benefits can be achieved. Further studies with more cattle are required to confirm this finding.

Table 3.1 Effect of Processing the LLHOG Oat on feeding performance

Parameter	Processed	Whole	SEM	P value
Liveweight				
Initial (kg)	222.9	221.1	6.01	0.85
Final (kg)	312.3	308.0	9.98	0.79
Gain (kg)	89.4	86.9	3.98	0.70
DMI (kg/d)	7.2	7.5	0.11	0.19
ADG (kg/d)	0.97	0.94	0.04	0.70
Intake (%)	2.54	2.63	0.08	0.49

4.0 Feedlot Finishing Study

4.1 Study Design

Two hundred forty crossbred steers were purchased from local auction markets in November 2004 and transported to the Beef Cattle Research Unit near the University of Saskatchewan, Saskatoon, SK. Cattle were processed using the induction protocol as described in the previous experiment. Cattle were fed processed grass hay for the first three days following arrival and then switched to a backgrounding diet consisting of 50% barley silage, 20% grass hay, 5% supplement pellets and 25% barley grain (as fed basis) until the experiment started.

The feedlot performance trial started on November 10, 2004. Steers (341.6 ±62.6 kg) were assigned by weight to one of 24 pens (10 head per pen) and one of three dietary treatments in a randomized complete block design to determine the effect of grain source on cattle performance, ultrasound carcass measurements and carcass characteristics. The pen was the experimental unit. Steers were kept outside in pens measuring 12 m wide x 24 m deep with 3.3 m high 20% porosity windbreak fencing, automatic water bowls and a concrete feed bunk. Steers were weighed in the morning on two consecutive days and an average weight was calculated to determine initial weight. Ultrasound measurements for rib-eye area and backfat thickness were taken at the start of test. Throughout the trial, steers were weighed bi-weekly unshrunk prior to the morning feeding. At the end of the test, steers were weighed unshrunk on two consecutive days and an average weight was calculated to determine final weight. Ultrasound measurements for rib-eye area and backfat thickness were taken at the end of test.

Barley silage was obtained from the University of Saskatchewan farm. Barley and LLH-HOG grains were processed in a Roskamp Model J roller mill. Dry-rolled corn was purchased

from New-Life Feeds in Saskatoon, SK. Ingredient composition for the finishing diets is presented in Table 4.1.

The steers were backgrounded for 57 days at the start of the feedlot finishing performance trial. A series of step-up rations was formulated to slowly adjust the steers to the final finishing diet. The percentage of grain in each of the step-up diets did not increase by more than 10% (DM basis) and the steers were fed each step-up diet for a minimum of 3 days before changing diets. Steers were weighed bi-weekly unshrunk prior to the morning feeding. Leftover feed was removed from the feedbunks, weighed and recorded. Individual feed ingredients and complete mixed diet samples were collected bi-weekly and frozen at -20° C for subsequent chemical analysis. Steers were removed from test when live weight reached 650 kg or 10 mm ultrasound backfat was measured or exceeded 200 days on feed. Steers that did not reach the target EOT live weight or backfat thickness and exceeded 200 days on feed were weighed on day

Table 4.1 Ingredient and formulated nutrient composition of finishing diets

	Day 1-57			Day 57-EOT		
	Barley	Corn	LLH-HOG	Barley	Corn	LLH-HOG
Barley silage	36.16	36.16	36.19	5.11	5.11	5.11
Barley grain	59.53	0.28	1.30	90.30	-	2.12
LLH-HOG grain	-	-	54.74	-	-	88.23
Corn	-	54.77	-	-	88.24	-
Urea	-	0.89	-	-	1.03	-
Canola meal	1.33	4.95	4.88	1.67	2.78	1.71
Calcium carbonate	1.01	0.99	0.91	1.24	1.15	1.10
Trace mineral salt[a]	0.45	0.45	0.45	0.44	0.43	0.44
Vitamin premix[b]	0.80	0.79	0.80	0.64	0.63	0.65
Vitamin E premix[c]	0.01	0.01	0.01	0.01	0.01	0.01
Monensin sodium premix[d]	0.45	0.45	0.45	0.41	0.40	0.41
Tallow	0.32	0.32	0.32	0.23	0.23	0.23
Formulated nutrient profile						
DM %	48.5	48.5	48.5	79.3	79.3	79.3
CP %	13.1	13.0	13.1	12.0	12.0	12.0
TDN %	72.3	74.5	72.0	79.4	83.8	79.5
DE (Mcal/kg)	3.18	3.28	3.17	3.49	3.69	3.50
NEm (Mcal/kg)	1.71	1.77	1.70	1.92	2.06	1.93
NEg (Mcal/kg)	1.09	1.15	1.08	1.28	1.39	1.28
Ca %	0.55	0.59	0.57	0.55	0.53	0.53
P %	0.37	0.38	0.38	0.35	0.35	0.35

a Sodium 36.5%, Salt 91.5%, Zinc 12,000 mg/kg, Manganese 10,000 mg/kg, Copper 4,000 mg/kg, Selenium 120 mg/kg, Iodine 200 mg/kg, Cobalt 60 mg/kg.
b Vitamin A 10,000,000 IU/kg, Vitamin D_3 1,000,000 IU/kg, Vitamin E 10,000 IU/kg.
c Vitamin E 500,000 IU/kg
d Monensin sodium 5,000 mg/kg.

210 and 211 of test and subsequently shipped for slaughter. At the end of the test, steers were weighed unshrunk on two consecutive days and an average weight was calculated to determine final weight. Ultrasound measurements for rib-eye area and backfat thickness were taken at the end of test.

Data collected during the finishing performance trial was used to measure the following performance parameters: weight gain, average daily gain, dry matter intake, feed efficiency and days on feed.

Forty steers were shipped to Plains Processors in Carman, MB to facilitate the harvesting of meat and fat samples required for the detailed meat quality study. In addition to collecting the standard carcass data, the 8-bone rib section from the right side of each carcass was removed, vacuum packaged and shipped to the University of Saskatchewan for detailed rib dissection. All other steers from this trial were processed at XL Foods Ltd. in Moose Jaw, SK.

Data collected from the finishing performance trial was analyzed as randomized complete block design. Statistical analysis was performed using the Proc Mixed procedure of the SAS Institute, Inc. (1998). Dietary treatment (barley or LLH-HOG or corn) was the fixed effect and the block was the random effect. Pen average was the experimental unit. The degree of freedom for means was determined using the Kenward-Roger option. Pen averages were calculated and Fisher's Least Significant Difference test was used to test the means comparison for significance. Significance was declared at $p \leq 0.05$.

4.2 Results & Discussion

The results of the finishing trial are given in Table 4.2. In contrast to the backgrounding results, the performance of the LLH-HOG oat fed cattle was reduced. This was evident through

out the entire feeding trial. For the first 57 days of the trial, relative to both the barley and corn fed cattle, the oat fed cattle had lower dry matter intakes and as a result had lower daily gains. The intakes and gains of the barley- and corn-fed cattle were similar during this period. Of significance, is the fact that the oat-fed cattle were the most efficient in their gain to feed ratios (Table 4.2) during the first 57 days of finishing.

Similar results were observed over the remainder of the finishing period, where performance including daily gain, feed intake and ultrasound measurements followed the order corn > barley > oat-fed cattle. Overall, cattle fed the oat-based diet consumed 1.12 and 1.66 kg/d less total dry matter than the barley and corn-fed cattle, respectively. To consider the impact of the lower dry matter intakes of the oat-fed cattle consider that a 425 kg steer consuming the 3 diets would consume 7.09, 8.54 and 10.60 Mcal per day of net energy for gain (NEg) from the oat, barley and corn diets, respectively (this assumes that the barley and oat diets were equal in energy and the corn diet was 4 % higher). Lower net energy intakes throughout the finishing phase would be directly accountable for the poorer performance of the oat-fed cattle.

Live animal ultrasound measurements of carcass backfat and ribeye area indicated slower rates of muscle and adipose tissue development for the oat-fed cattle (Table 4.3). As a consequence of the reduced rate of gain of the oat-fed cattle, days on feed were 13 days longer than for the barley-fed cattle, which in turn were on feed 8 days longer than the corn-fed cattle.

A summary of the carcass characteristics is presented in Table 4.4. The results are a mirror image of the live animal performance and ultrasound results and can be attributed to the lower dry matter intakes of these cattle. Oat-fed cattle exhibited reduced carcass weights, lower dressing %, reduced grade fat and reduced ribeye area. Carcasses of barley-fed cattle were similar in these traits to corn-fed cattle with the exception that corn-fed cattle tended to have

higher levels of grade fat, which resulted in lower lean yields for these cattle. Marbling scores were slightly higher ($P<0.05$) for the oat-fed cattle indicating poorer marbling. Table 4.5 gives 8-bone rib dissection results from 13 steers per treatment. There was no difference in muscle, fat or bone percentages between treatments, other than a trend ($P<0.08$) to higher inter-muscular or seam fat content in barley and corn-fed cattle.

The reduced performance of the LLH-HOG oat-fed cattle is attributable to the lower dry matter intake and as a consequence lower net energy for gain intake of these cattle relative to those fed either barley or corn. The question that needs addressing is what led to the lower intakes of these cattle. It was noted by the authors that during feeding, the oat hull tended to separate from the groat relatively easily and accumulate in the bunk. This could negatively affect feed intake through increased fines. Of greater significance, is the fat content of the LLH-HOG oat used for these studies. The groat contained 9.4% fat. At an intake of 9.21 kg DMI per day for the oat-fed cattle, this would amount to 11.5 kg as fed or 9.09 kg of oat per day (as fed). Daily groat intake (assuming 25% hull) would equal 6.82 kg/day or 0.64 kg fat intake per day. Expressed as a % of dry matter intake this equates to a calculated value of 6.96% fat in the diet DM. In fact actual fat content of the finishing diet was 8.0% on a DM basis. Dry matter intakes of dairy cows have been shown to be negatively affected when fat levels of the diet approach 6.0% or greater. This has been attributed to negative effects of fat, particularly unsaturated fat on rumen bacteria and a reduction in fibre digestibility due to coating of feed particles by the lipid. It is possible that the fat level of the LLH-HOG oat used in this trial was excessive and caused a reduction in feed intake which in turn resulted in reduced live animal performance as well as poorer carcass traits. Further work is required to determine the effects of the fat content of the LLH-HOG oat on feed intake of finishing cattle. It is worth noting that the relative ease which

the hull separated from the groat would compound this negative effect of fat on intake as cattle consuming the groat would consume a more concentrated form of the fat. It should also be noted that this negative effect of fat on feed intake was not seen in the backgrounding studies, as fat intakes would not approach a level that would negatively impact intake.

5.0 Conclusions

Value of LLH-HOG Oat in Backgrounding Diets

Performance of cattle fed LLH-HOG oat in backgrounding diets designed to target daily gains of approximately 1.2 kg/d is equal to that of barley-fed cattle. Furthermore, the oat-fed cattle were superior in terms of the efficiency of gain and lean tissue growth. This latter observation is particularly important for backgrounding diets which are designed for lean tissue.

It was also noteworthy that the performance of calves fed processed LLH-HOG was not any different to that of calves fed unprocessed LLH-HOG. A potential cost savings of $5 to $15 per tonne of grain can be realized by producers if dry-rolling grain does not result in significant improvements in backgrounding cattle performance. Additional research is required to confirm this preliminary conclusion.

Value of the LLH-HOG Oat in Finishing Diets

In contrast to the results of the backgrounding phase, cattle fed the LLH-HOG diet exhibited poorer finishing performance. This included lower ($P<0.05$) ADG and DMI and poorer ($P<0.09$) gain to feed ratios. As a result the oat-fed cattle required longer to reach the targeted end point and had reduced carcass weights, lower dressing % and reduced carcass fat and ribeye area. It was concluded that the poorer performance of the oat-fed cattle during finishing was a

result of lower dry matter intakes due to excessive fat levels in the diet. Further research is required to determine the optimal level of the LLH-HOG oat to be fed to cattle that optimizes fat intake yet minimizes any disruption in feed intake.

Overall with respect to use of this new oat variety in backgrounding diets, these results are very favorable. Similar or superior performance, particularly if no processing is required would reduce feeding costs relative to traditional barley-based diets. It would simply be a matter of comparing costs per unit of energy and incorporating the cheaper product. The lack of a need to processing would be a significant plus for the LLH-HOG oat grain. Producer's who grow their own cereal grains, would benefit from the higher yield of oat relative to barley and may lower growing costs. As indicated above, further research is required to optimize use in finishing diets.

Table 4.2. Finishing performance of cattle fed LLH-HOG oat, barley or corn-based finishing diets.

	Diet				
Parameter	Oat	Barley	Corn	SEM	P value
Liveweight					
Initial (kg)	341.2	341.8	342.0	0.41	0.35
Day 57 (kg)	432.4*a*	437.3*b*	437.3*b*	1.38	0.03
Final (kg)	623.3*a*	644.8*b*	647.7*b*	3.17	<0.01
Day 1-57					
Gain (kg)	91.2*a*	95.5*b*	95.2*b*	1.30	0.05
DMI (kg/d)	8.22*a*	9.06*b*	9.33*b*	0.10	<0.01
ADG (kg/d)	1.63*a*	1.71*b*	1.70*b*	0.02	0.05
Gain:Feed	0.198*a*	0.188*b*	0.183*b*	0.003	<0.01
Intake [z] (%)	2.11*a*	2.32*b*	2.39*c*	0.02	<0.01
Day 57-EOT					
Gain (kg)	190.9*a*	207.5*b*	210.4*b*	3.10	<0.01
DMI (kg/d)	9.56*a*	10.84*b*	11.56*c*	0.13	<0.01
ADG (kg/d)	1.40*a*	1.69*b*	1.84*c*	0.03	<0.01
Gain:Feed	0.147*a*	0.156*b*	0.159*b*	0.002	<0.01
Intake [z] (%)	1.76*a*	1.94*b*	2.07*c*	0.02	<0.01
Days on Feed	136*a*	123*b*	115*c*	1.36	<0.01
Overall					
Gain (kg)	282.1*a*	303.0*b*	305.7*b*	3.26	<0.01
DMI (kg/d)	9.21*a*	10.33*b*	10.87*c*	0.11	<0.01
ADG (kg/d)	1.47*a*	1.69*b*	1.79*c*	0.02	<0.01
Gain:Feed	0.160	0.164	0.165	0.002	0.09
Intake [z] (%)	1.82*a*	2.01*b*	2.13*c*	0.02	<0.01
Days on Feed	192*a*	179*b*	171*c*	1.36	<0.01

a,b,c Means followed by a different letter are significantly different ($P \leq 0.05$).

z Intake expressed as average dry matter intake/average body weight for period.

Table 4.3. Ultrasound carcass measurements of cattle fed LLH-HOG oat, barley or corn -based finishing diets.

	Diet				
	Oat	Barley	Corn	SEM	P value
Day 1-56					
Initial Backfat Depth (mm)	2.8	2.7	2.4	0.18	0.35
Final Backfat Depth (mm)	4.2*a*	4.6*ab*	3.8*ac*	0.16	0.01
Initial Ribeye area (cm^2)	63.6	61.5	62.9	0.91	0.30
Final Ribeye area (cm^2)	72.6*a*	70.7*ab*	73.8*ac*	0.62	<0.01
Day 57-EOT					
Initial Backfat Depth (mm)	4.2*a*	4.6*ab*	3.8*ac*	0.16	0.01
Final Backfat Depth (mm)	8.5*a*	8.8*ab*	10.0*bc*	0.37	0.02
Initial Ribeye area (cm^2)	72.6*a*	70.7*ab*	73.8*ac*	0.62	<0.01
Final Ribeye area (cm^2)	91.2*a*	96.6*b*	98.1*bc*	0.89	<0.01
Overall					
Initial Backfat Depth (mm)	2.8	2.7	2.4	0.18	0.35
Final Backfat Depth (mm)	8.5*a*	8.8*ab*	10.0*bc*	0.37	0.02
Initial Ribeye area (cm^2)	63.5	61.5	62.9	0.91	0.30
Final Ribeye area (cm^2)	91.2*a*	96.6*b*	98.1*bc*	0.89	<0.01

a.b.c Means followed by a different letter are significantly different ($P<0.05$)

Table 4.4. Carcass characteristics of cattle fed LLH-HOG oat, barley or corn-based finishing diets.

	Diet				
Parameter	Oat	Barley	Corn	SEM	P value
Carcass weight (kg)	353.4*a*	373.5*b*	378.1*b*	2.40	<0.01
Dressing (%)	58.3*a*	59.7*b*	60.1*b*	0.17	<0.01
Average fat (mm)	8.7	8.8	10.1	0.46	0.08
Grader fat (mm)	7.7*a*	7.8*ab*	9.2*c*	0.43	0.04
Grader ribeye area (cm^2)	95.6*a*	101.8*b*	100.5*b*	1.03	<0.01
Marbling score	7.9*a*	7.7*b*	7.7*b*	0.08	0.04
Ruler yield (%)	61.4*a*	61.5*ab*	60.5*c*	0.32	0.05
Liver abscess	1.3	1.1	0.9	0.14	0.16

a,b,c Means followed by a different letter are significantly different (P<0.05)

Table 4.5. Rib Dissection Characteristics of cattle fed LLH-HOG oat, barley or corn-Based finishing diets.

	Diet				
Parameter	Oat	Barley	Corn	SEM	P value
Bone (%)	11.4	11.6	11.1	0.51	0.82
Lean meat (%)	61.0	60.8	60.4	1.06	0.92
Total fat (%)	27.6	27.7	28.5	1.07	0.80
Subcutaneous fat (%)	36.6	33.6	33.5	1.18	0.13
Body cavity fat (%)	5.8	6.1	5.6	0.30	0.50
Intermuscular fat (%)	57.6	60.4	61.0	1.04	0.08

a,b,c Means followed by a different letter are significantly different (P<0.05)

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LOW LIGNIN HULL, HIGH OIL GROAT OAT GRAIN IN LACTATING DAIRY COW RATIONS

A Thesis Submitted to the College of

Graduate Studies and Research

in Partial Fulfillment of the Requirements

for the Degree of Master in Science in the

Department of Animal and Poultry Science

University of Saskatchewan

Saskatoon, Saskatchewan,

Canada

By

Leland Gustav Michael Fuhr

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2.4 Objectives of Thesis

Few studies have evaluated oat grain as a dairy feed. It has been shown that oat grain in dairy rations can support milk production of 25 kg per day. Oat grain has also been shown to maintain or raise MF and lower MP content. The current average daily production of milk in Canadian Holstein dairy cattle is approximately 30 kg per day. Because of this, it is doubtful that historic observations on oat grain and other cereals will be valid in today's Canadian dairy rations. With this in mind, the Crop Development Centre has developed low-lignin hull, high-oil groat (LLH-HOG) oat. It is hypothesized that the low lignin and high oil content of LLH-HOG oat will improve digestibility and energy content when fed to dairy cattle, such that it is better than regular oat and comparable or superior to barley. The combination of low lignin hull and high oil groat in LLH-HOG oat will result in a nutritionally superior grain for ruminants when compared to Derby oat and nutritionally similar compared to CDC Dolly barley.

The objectives of this study were:

(1) to determine the nutritional characteristics of three cereal grains, LLH-HOG oat, Derby oat, and CDC Dolly barley,

(2) to evaluate total tract digestibility of LLH-HOG oat and CDC Dolly barley,

(3) to evaluate *in situ* and *in vitro* rumen degradability of LLH-HOG oat compared to CDC Dolly barley, and

(4) to determine the nutritional impact of LLH-HOG oat and Derby oat when replacing CDC Dolly barley in high production, lactating dairy cow rations.

3.4 Conclusions

The results of this study indicate that the 01-499-04 LLH-HOG oat has similar nutritional characteristics to CDC Dolly barley and improved nutritional properties compared to Derby oat. Although the sample of 01-499-04 LLH-HOG oat had poor physical properties due to the growing season, it did excel in several important aspects. As expected, the NDF, ADF, and EE content of the oat grains were greater than that of the barley. In fact, 01-499-04 LLH-HOG oat and Derby oat had higher than previously reported values of NDF and ADF for oat (Moe et al. 1973; Rowe and Crosbie 1988; Herrera-Saldana et al. 1990; National Research Council 2001). The intended differences in lower ADL content and higher EE content for 01-499-04 LLH-HOG oat versus Derby oat were confirmed. The result was a high GE and higher TDN and NE_L values for 01-499-04 LLH-HOG oat versus to Derby oat and other reported values for oat. Despite having substantial EE content, 01-499-04 LLH-HOG oat had an EE content lower than some values previously reported (de la Roche et al. 1977; Sahasrabudhe 1979). The major difference between grains in amino acid content was in percent proline. CDC Dolly barley protein contained more proline than either oat, indicating that as dairy feed CDC Dolly barley may support higher milk fat yields (Bruckental et al. 1991). It was apparent that all of the experimental grains could not provide the appropriate recommended balance of lysine and methionine for lactating dairy cattle, as determined by Rulquin and Verite (1993). As such, these amino acids would need to be provided from another source.

The nutrient composition and characteristics of 01-499-04 LLH-HOG oat greatly influenced its digestibility characteristics. When fed to sheep, 01-499-04 LLH-HOG oat showed similar digestibility to CDC Dolly barley. The apparent DM digestibility of 01-499-04 LLH-HOG oat was lower than that of CDC Dolly barley. Nevertheless, the high GE content of 01-499-04 LLH-HOG oat translated into DE similar to CDC Dolly barley. Unfortunately, the DMI of 01-499-04 LLH-HOG oat diets by sheep were considerably lower than the intake of CDC Dolly barley diets. The cause of the lower intake is not clear but it is possible that it is related to the greater fibre content of oat. Depression of feed intake could be achieved through the accumulation of slowly digested fibre in the rumen, leading to gut fill, which limits intake. If this is the situation, added processing may increase the intake of this oat in sheep. Increased lipid in ruminant diets has been shown to impede fibre digestion. It also is possible that with increasing grain the lipid content of rations increased to the point where fibre digestion was decreased. This may have caused the accumulation of fibre in the rumen, depressing intake.

The 01-499-04 LLH-HOG oat *in situ* incubations displayed greater NDF degradability over 24 hours than Derby oat. This property of 01-499-04 LLH-HOG oat was a direct result of its low ADL content in comparison to conventional oat grains. ADL impedes the digestion of nutrients associated with it. Thus, lower ADL content improves the digestibility of the associated nutrients, particularly of the associated structural carbohydrates. Even though the ruminal degradation of 01-499-04 LLH-HOG oat NDF was improved, it remained lower than the ruminal degradability of NDF in CDC Dolly barley. Despite this, the amount of degradable NDF in 01-499-04 LLH-HOG oat was the same as that of CDC Dolly barley after 48 hours of *in vitro* incubation. The improved

NDF degradability had little effect on the total DM ruminal degradability of 01-499-04 LLH-HOG oat in comparison to Derby oat.

One clear difference between barley and oat was the solubility of protein. The 01-499-04 LLH-HOG oat and Derby oat had greater protein solubility than CDC Dolly barley. A rapidly soluble protein may not provide by-pass protein in the form of ruminal undegradable protein, but if rumen outflow becomes fast enough, rapidly soluble protein may contribute to by-pass protein. The soluble protein in oat may be considered disadvantageous if enough fermentable carbohydrate is not supplied. Matching these two nutrients in supply and fermentation rate can optimize microbial protein synthesis, while other scenarios would be energy inefficient. Despite the rapid solubility of oat CP, the results observed in the *in situ* trial did not translate into a substantial advantage in apparent digestibility of CP compared to CDC Dolly barley. Although not enough incubation times were used for the fitting of the Ørskov and McDonald (1979) equation in the *in vitro* study, the use of the Daisy *II* Incubator (Ankom Technology 2005) supported the findings of the *in situ* trial.

4.0 OAT GRAIN IN DAIRY TOTAL MIXED RATIONS

4.4 Conclusions

Dairy cows fed 01-499-04 LLH-HOG oat containing TMR yielded as much milk as cows fed CDC Dolly barley TMR. Feeding 01-499-04 LLH-HOG oat TMR also yielded similar MF and MP but had a significantly lower MP concentration than cows fed the CDC Dolly barley TMR. Very few studies have been conducted on oat grain in dairy rations, but those reviewed support the findings of the current study. Although the NDF concentrations of the oat TMR were greater than that of the CDC Dolly barley TMR,

DMI by dairy cows were not different. Dairy cattle also showed no preference when consuming concentrates that contained CDC Dolly barley or 01-499-04 LLH-HOG oat. The 01-499-04 LLH-HOG oat did show improved production compared to Derby oat with a trend to yielding more milk (P=0.09) and MP (P=0.08) from dairy cows fed these oat. The DMI required to yield 100 kg of FCM also trended (P=0.08) lower in cows fed 01-499-04 LLH-HOG oat rations as compared to those fed Derby oat. For this reason it is appropriate to conclude that 01-499-04 LLH-HOG oat, when included in dairy TMR, supplied more energy for the support of high milk yields than did conventional oat grain.

Cows spent more time consuming oat containing TMR than they did barley TMR. Based on NDF concentration and total amount of time cows spent chewing, oat rations may have caused greater saliva production in dairy cows. For this reason it is possible that oat based TMR may have higher ruminal buffering capacity than the barley based TMR.

The apparent digestibility of DM and NDF, and the DE content of 01-499-04 LLH-HOG oat TMR in dairy cows were significantly greater than that for Derby oat TMR. These characteristics of 01-499-04 LLH-HOG oat TMR were also similar to that of CDC Dolly barley TMR. The low-lignin and high-oil characteristics of 01-499-04 LLH-HOG oat made its nutritional qualities in dairy cattle superior to conventional oat and similar, if not better, than barley. The low ADL content of 01-499-04 LLH-HOG oat improved apparent digestibility of NDF and DM, and in combination with the high-oil content, the low-lignin content of 01-499-04 LLH-HOG oat also improved the digestible energy value of this oat breeding line.

1.0 GENERAL DISCUSSION

The 01-499-04 LLH-HOG oat was similar to Derby oat in nutrient composition, with the exception of EE, ADL, and CP content. The 01-499-04 LLH-HOG oat had higher EE, lower ADL, and higher CP, translating into more GE and a greater DM and NDF digestibility. All grains evaluated, including CDC Dolly barley, had unusually high NDF concentrations as compared to published values. For this reason the grain samples from the present study may not have been fully representative of commercial grain of the same type. The 2003 growing season was relatively hot and dry, suggesting that in a normal season these grains may have had lower NDF contents. Other side effects experienced because of the 2003 season included lower than typical TW and plumpness in the oat samples. Although 01-499-04 LLH-HOG oat was a high-oil oat, its lipid content was not as high as some other high-oil oat. The calculated TDN concentration and NE_L content of 01-499-04 LLH-HOG oat were higher than those of the regular oat and similar to barley.

The DMI of oat diets were significantly lower than barley diets fed to sheep. Palatability and/or NDF related rumen fill may have caused the decreased intake. The depressed digestibility of NDF, leading to rumen fill, may have been a result of the high lipid levels in oat upsetting fibre digestibility. Contrary to the digestibility trial, DMI of dairy TMR containing oat or barley were not different. Dairy cows showed no preference when consuming concentrate containing either 01-499-04 LLH-HOG oat or CDC Dolly barley. The species difference for oat preference of cattle and sheep may be a function of the size of the reticulo-omasal orifice, which is larger in cattle. Rolled oat in dairy TMR can be fed to dairy cattle without negative preference or palatability effects.

When fed to sheep, 01-499-04 LLH-HOG oat had similar apparent digestible energy content to CDC Dolly barley. Also, the DE content of 01-499-04 LLH-HOG oat TMR was similar to that of CDC Dolly barley TMR. Because there was no DMI difference by dairy cows the TMR were supplying the same total DE. High producing dairy cattle were able to maintain body weight when fed any of the three TMR. The apparent digestibility of DM, NDF and the DE content of 01-499-04 LLH-HOG oat TMR in dairy cows were similar to CDC Dolly barley TMR and greater than Derby oat TMR.

Because of its lower ADL content, 01-499-04 LLH-HOG oat displayed greater NDF degradability over 24 hours than Derby oat in the *in situ* trial. The NDF degradability of 01-499-04 LLH-HOG oat was improved but remained lower than CDC Dolly barley. Regardless of its lower ADL content, 01-499-04 LLH-HOG oat did not have different ruminal DM degradability than Derby oat. Nevertheless, as previously noted, 01-499-04 LLH-HOG oat TMR had a higher DM digestibility than Derby oat TMR. The NDF content of oat TMR was greater than that of barley TMR. Despite this and the noted differences in the grains, all TMR in the dairy trial were close in GE. Even so, the higher EE and lower ADL of 01-499-04 LLH-HOG oat provided more DE and digestible NDF to lactating dairy cows than Derby oat. It is apparent that the digestibility of 01-499-04 LLH-HOG oat TMR was greater than that of Derby oat TMR and similar to CDC Dolly barley TMR.

Cows fed 01-499-04 LLH-HOG oat TMR yielded as much milk as those fed CDC Dolly barley TMR. This is significant since the experimental TMR contained around one third oat or barley grain. MF and MP yields were also similar, however MP concentration was significantly lower in cows fed 01-499-04 LLH-HOG oat. The amount of 01-499-04

LLH-HOG oat TMR required to yield 100 kg FCM trended (P=0.08) lower than the amount of Derby oat TMR required. When fed to dairy cattle, 01-499-04 LLH-HOG oat showed improved production characteristics versus Derby oat because of its improved digestibility and greater energy content. In addition, 01-499-04 LLH-HOG oat showed similar production characteristics to that of CDC Dolly barley.

There are many special considerations when feeding oat to dairy cattle. It is possible that the higher NDF concentration and greater amount of time spent chewing oat TMR may have caused a greater capacity for rumen buffering. The high NDF content of oat may also allow it to substitute a portion of the forage NDF in dairy TMR. This would be advantageous when considering 01-499-04 LLH-HOG oat because it has similar nutritional value to that of barley and would thus provide more energy if it could be fed at a higher concentration. Another special consideration of oat is its CP solubility. Oat CP was more soluble than that of barley. The carbohydrate fermentation of oat diets would have to match protein fermentation in the rumen to maximize microbial protein and prevent energy inefficiency. Oat has a high CP content and because of this it will provide some of the supplemental protein. Additional RUP may need to be supplemented because of oat's highly solubility CP.

From the results of this study it was apparent that, because of its low ADL and high EE content, 01-499-04 LLH-HOG oat was more satisfactory for milk production than Derby oat and was similar to CDC Dolly barley. The 01-499-04 LLH-HOG oat, as described in this study, would be an excellent cereal grain for feeding lactating dairy cows in western Canadian dairies.

Request for Support for Registration of *OT3017*

Crop: Oat (*Avena sativa L.*)
Type: Spring oat

Proposers: B.G. Rossnagel, T. Zatorski, G. Arganosa
Crop Development Centre
University of Saskatchewan
51 Campus Drive
Saskatoon, SK. S7N 5A8

Test #'s: OT3017 or SO02174
Pedigree: AC Assiniboia/SA96121
Area of Adaptation: Western Canada

Note: OT3017 is proposed for support after one year of Coop testing and one year of evaluation in the Rust Area Test because of its combination of low acid detergent lignin hull (LLH) and high oil groat (HOG) characteristics. This would be the first commercial release of such a combination of traits in oat and will prove beneficial for feed producers.

Enclosure: Letter from SuperOats Canada Ltd. indicating specific market use.

Description:

OT3017 is a spring oat with low acid detergent lignin hull in combination with elevated groat oil content. This LLH-HOG trait combination gives a whole grain oat with feed quality (digestible energy) for ruminants equal to barley. It has shown good overall agronomic performance combined with average quality characteristics common for feed purposes. OT3017 is resistant to smut.

Strengths:

- Low acid detergent lignin hull.
- High oil content – 2-3% > CDC Dancer and Morgan.
- Yield potential – similar to CDC Dancer and Ronald.
- Early maturing – similar to CDC Dancer.
- High kernel weight with plumpness similar to CDC Dancer.
- Resistant to smut.

Neutral characteristics:

- Plant height.
- Resistance to lodging.
- Test weight and % groat – similar to Morgan.
- Resistance to Stem Rust – similar reactions as Ronald, susceptible to race *NA67*.
- % Protein.

Weaknesses:

- Susceptible to Crown Rust (likely carries *Pc68* but susceptible to new crown rust races).

Table 1. Grain yield (kg/ha) for OT3017 and checks from 2005 Western Oat Cooperative trial.

Entry	Black Soil Zone	(%) CDC Dancer	Black & Grey Soil Zone	(%) CDC Dancer	Brown Soil Zone	(%) CDC Dancer	Irrigated Lethbridge	(%) CDC Dancer	West. Can. Total	(%) CDC Dancer
Ronald	4445	84	8241	106	6517	97	7154	99	6454	97
CDC Dancer	5315	100	7749	100	6711	100	7208	100	6633	100
Morgan	5009	94	8587	111	6218	93	8333	116	6781	102
OT3017	***5730***	***108***	***7927***	***102***	***6864***	***102***	***6949***	***96***	***6848***	***103***
#SY	*4*		*4*		*3*		*1*		*12*	

Table 2. Agronomic characteristics for OT3017 and checks from 2005 Western Oat Cooperative trial.

Entry	Days to Head	Days to Mature	Height (cm)	Lodge (1 - 9)	Test Wt. (kg/hl)	Kern. Wt. (mg)	Plump (%)	Thins (%)	Groat (%)	Groat Vis. Breakage Score
Ronald	66	102	99.5	2.7	48.3	32.0	59.1	12.7	62.2	3.0
CDC Dancer	64	98	112.4	2.4	50.1	35.9	85.1	3.3	68.8	4.0
Morgan	65	100	108.0	3.2	47.3	36.1	87.3	5.0	58.2	4.0
OT3017	***64***	***99***	***103.1***	***2.9***	***45.9***	***39.1***	***86.7***	***2.7***	***62.2***	***4.0***
#SY	*6*	*11*	*11*	*8*	*13*	*13*	*6*	*6*	*6*	*6*

Table 3. Grain quality characteristics for OT3017 and checks from 2005 Western Oat Cooperative trial.

	Groat[a]		Fibre Analysis[b]		NIT[c]			ADL[d]		
Entry	Protein (%)	Oil (%)	β-Gluc (%)	TDF (%)	Protein (%)	Oil (%)	Groat (%)	Kernen (%)	Lacombe (%)	Average (%)
Ronald	14.0	8.2	5.1	15.2	14.4	7.8	71.7	4.16	3.95	4.06
CDC Dancer	13.7	6.1	4.5	13.7	13.1	5.6	75.7	4.23	3.56	3.90
Morgan	12.1	5.9	4.4	13.7	12.4	5.6	68.6	4.63	4.89	4.76
OT3017	***14.2***	***8.0***	***4.3***	***13.9***	***15.5***	***7.2***	***72.2***	***0.36***	***0.68***	***0.52***
#SY	*5*	*5*	*3*	*3*	*1*	*1*	*1*	*1*	*1*	*2*

[a] *Percent protein, oil, and β-Glucan values were determined using near infrared reflectance (NIR) spectroscopy. CRC, Wpg.*
[b] *Standard analytical procedures used to quantify β-Glucan and total dietary fibre. CRC, Wpg.*
[c] *Percent protein, oil, and groat determined using NIT. CDC, U of S.*
[d] *ADL = Acid Detergent Lignin – determined using Ankom Fibre Analyzer. CDC, U of S.*

Table 4. Disease reaction summaries for OT3017 and checks from 2005 Western Oat Coop. trial.

Year: 2005	Portage OCR Field Rating			Oat Crown Rust Greenhouse Rating						
Entry	Rep 1	Rep 2	Rep 3	CR13	CR200	CR223	CR225	CR241	CR249	CR254
Ronald	20 S	40 S	30 S	;-/3f	0	;-	;	0	;-	4
CDC Dancer	2 MR MS	Tr R MR Tr S	5 MR MS	;	4	;-	;1-	12(4)	4	;-
Morgan	40 S	40 S	20 S	3	4	34	4	4	4	4
OT3017	***20 MR MS***	***10 MS-S***	***10 S***	***0 4sp***	***0***	***0;-***	***;-***	***0***	***0 4sp***	***4***

Year: 2005	Oat Stem Rust							
Entry	NA8	NA16	NA25	NA27	NA28	NA55	NA67	BYDV
Ronald	;1	1-	1-1	1	1-1	;1	4	6.5
CDC Dancer	;1	1-	12-	11+	1	;1	34	7.0
Morgan	4	4	34	4	4	34	34	6.5
OT3017	***;1-***	***;1-***	***1+-***	***12***	***11+***	***;1***	***4***	***4.0***

Disease nurseries co-ordinated by **J. M. Fetch** – OCR field rating taken on three reps of the naturally infected 2005 Portage yield rial site. BYDV data - **S. Haber**. Virulent R. padi non-specific isolate Y9301 (PAV-like) was used. Readings were taken at the mid-dough stage using 1-9 (best-worst) scale. Data is averaged over five individual plants per pot. Smut data - **J. Menzies**: NA in 2005. Note that at least three years are required to assess the smut resistance of entry with confidence. Oat Crown Rust - **J. Chong**. Reactions in greenhouse tests based on infection types. Reactions in field were scored using the modified Cobb scale. Oat Stem Rust – **T. Fetch**: Field ratings NA in 2005. Where a line segregates for disease resistance the first number in the seedling reaction score for stem rust indicates the number of plants and the second number in brackets indicates the infection type. Infection types are based on a 0-4 scale where ;(fleck), 1 and 2 are indicative of resistance while 3 and 4 indicate susceptibility. Numbers followed by plus (+) and (-,=) signs refer to gradients in pustule size.

Table 5a. Additional agronomic data from the 2004 Rust Area Trial.

Entry	Yield* (Kg/Ha)	Heading (Days)	Maturity (Days)	Height (cm)	Lodging (1-9)	TWT (Kg/Hl)	MKW (G)	Plump (%)	Thins (%)
Ronald	8261	60	109	101.3	1.3	54.6	31.9	96.1	3.9
CDC Dancer	8793	59	105	116.7	2.7	58.0	36.5	99.1	0.9
Morgan	9115	60	107	113.1	1.5	52.7	34.9	98.3	1.7
SO02174	***9230***	***58***	***104***	***107.4***	***1.3***	***54.3***	***40.6***	***99.2***	***0.8***
Grand Mean	7734.7	58.0	106.0	111.60	3.00	55.40	34.10	95.50	4.50
LSD	412.2	1.0	2.0	3.60	1.20	1.70	2.50	2.90	2.90
No. of Reps	15	9	15	18	15	5	6	6	6

** 3 reps x 5 sites (Indian Head, Morden, Portage la Prairie, Lacombe, Saskatoon)*

Table 5b. Additional quality data from the 2004 Rust Area Trial.

Entry	Codema - Groat (%)	Breakage	NIR - Groat (%) Protein	Oil	B-Glucan	Hull %
Ronald	71.8	2.0	13.2	8.6	8.6	25.4
CDC Dancer	76.1	4.0	12.6	6.7	6.7	20.8
Morgan	72.4	4.0	11.8	6.8	6.8	26.6
SO02174	***72.0***	***4.0***	***13.7***	***8.5***	***8.5***	***25.8***
Grand Mean	73.52	3.00	13.89	8.12	8.12	22.93
LSD			0.83	0.23	0.23	1.83
No. of Reps	1	1	5	5	5	5

Table 5c. Disease reaction summaries for OT3017 and checks from 2004 Rust Area Trial (RAT).

Entry	BYDV	SMUT	OCR Field Rating	OCR Greenhouse Rating CR13	CR200	CR223	CR225	CR241	CR249	CR254
Ronald	4.0	0	20MS-S	0	0	0	;-	0	0	4
CDC Dancer	7.6	0	20MR-MS	0	;	0	;	4	4	0
Morgan	6.1	0	60S	4	4	4	4	4	4	4
SO02174	***4.9***	***0***	***5S***	***0***	***0***	***0***	***;-***	***0***	***0***	***4***

Entry	OSR Field Rating	OSR Greenhouse Rating NA8	NA16	NA25	NA27	NA28	NA55	NA67
Ronald	20mr	;1	1+ -	1+ -	1+ -	1+ -	12-	4
CDC Dancer	20mr	;1	11+	1+ -	12	12+	;1	4
Morgan	20mss	4	4	4	4	4	3+	4
SO02174	***10rmr***	***;1-***	***;1***	***1+***	***12***	***12***	***12-***	***4***

Table 6a. Additional agronomic data from the 2003 CDC/U of S Standard Oat Yield Trial (SOYT *SY*=5).

Entry	Name	Yield* (kg/ha)	Yield as %Morgan	Days to Head	Days to Mature	Plant Ht. (cm)	S.S. (1 - 9)	Visual Sco. (1 - 9)	Vis.Sco-tz (1 - 9)
1	Morgan	3566	100	54	85	77	6	7.4	6.0
2	CDC Dancer	3276	92	53	81	81	6	5.9	6.3
3	Assiniboia	3089	87	54	85	77	5	5.5	5.0
4	CDC Orrin	3331	93	54	86	77	6	6.9	6.3
33	***SO02174***	***3327***	***93***	***53***	***83***	***70***	***5***	***6.7***	***6.5***
GRAND MEAN		3235.4		52.0	84.0	77.0	5.0	5.73	5.44
CV		10.0		1.0	1.0	5.0	11.0	18.76	15.89
LSD		194.3		1.0	1.0	4.0	1.0	0.72	0.83
No. of Reps		15		9	3	6	2	12	6

** 3 reps x 5 sites (Saskatoon, Kernen, Goodale, Canora, and Indian Head)*

Table 6b. Additional quality data from the 2003 CDC/U of S Standard Oat Yield Trial.

Entry	Name	Test Wt. (kg/hl)	Kernel Wt. (g/1000k)	Plump (%>5.5/64)	Thin (%<5.0/64)	NIT-Oil (%)	Protein (%)	NIT-GRT (%)	COD-GRT (%)	Vis Brk (1 - 9)
1	Morgan	55.5	36.3	78.3	3.1	4.9	12.0	68.2	67.3	5.0
2	CDC Dancer	55.9	32.1	84.3	3.9	5.2	13.0	74.5	72.5	5.0
3	Assiniboia	54.0	36.9	74.7	3.3	6.4	14.8	74.9	69.3	4.0
4	CDC Orrin	55.3	37.5	90.3	0.9	5.5	14.3	72.2	67.7	4.5
33	***SO02174***	***53.4***	***38.5***	***84.3***	***1.8***	***8.3***	***16.5***	***68.1***	***68.9***	***4.0***
GRAND MEAN		54.25	34.43	76.90	5.30	6.77	14.92	73.40	69.70	3.61
CV		1.19	3.88	9.00	57.20	4.23	4.48	2.53	1.21	14.43
LSD		1.09	2.26	11.70	5.10	0.48	1.13	3.14	1.42	0.88
No. of Reps		2	2	2	2	2	2	2	2	2

Trial: 2006 SOYT#1

Agronomic

Entry	Name	Pedigree	Yield (kg/ha)	Yield as %Dancer	Days to Head	Days to Mature	Plant Ht. (cm)	Ht. Sco. (1 - 9)	Lodging (1 - 9)	Visual Sco. (1 - 9)	Vis.Sco-tz (1 - 9)
1	CDC Weaver		6289	98	57.2	97.7	118.0	7.0	4.1	5.6	5.8
2	CDC Dancer		6423	100	56.6	94.0	118.8	6.0	3.6	6.4	5.7
3	OT3017		6325	98	56.7	95.8	113.2	4.7	2.7	6.8	6.2
7	SA04800	SA00406/Furlong	6052	94	56.1	94.4	124.8	7.0	2.8	5.6	5.2
25	SA04876	SA00489/Furlong	6164	96	56.0	97.3	113.8	4.7	1.1	5.5	4.8
GRAND MEAN			6268.7		56.66	96.15	118.52	6.08	3.75	5.71	5.74
CV			7.8		1.59	1.75	3.81	7.42	49.32	23.55	18.30
LSD			267.9		0.70	1.31	3.52	0.61	1.44	0.91	1.00
Max. Mean			6889		58.78	100.11	126.78	7.33	8.11	7.08	7.17
Min. Mean			5817		54.78	92.33	111.44	4.67	1.11	4.42	4.00
No. of Reps			18		9	9	9	3	9	12	6

Kernel Quality

Entry	Name	Pedigree	Test Wt. (kg/hl)	Kernel Wt. (g/1000k)	Plump (%>5.5)	Thin (%<5.0)	NIT Oil (%)	NIT Prot (%)	NIT Grt (%)	Codema Grt (%)	Vis. Brk (1 - 9)	Hull Col. (1 - 9)
1	CDC Weaver		50.9	44.1	85.9	3.1	6.2	13.0	68.2	68.2	3.5	2.0
2	CDC Dancer		52.2	32.8	81.3	3.6	4.9	11.4	71.0	65.2	3.0	5.5
3	OT3017		48.4	40.8	82.6	3.7	7.2	14.6	64.8	63.5	3.0	9.0
7	SA04800	SA00406/Furlong	50.1	38.8	77.7	6.1	6.5	13.4	68.8	67.3	3.0	7.0
25	SA04876	SA00489/Furlong	52.5	40.3	88.4	4.0	7.0	13.6	70.0	69.8	2.5	7.0
GRAND MEAN			51.63	38.06	80.87	4.21	5.99	13.02	67.30	65.78	2.94	4.03
CV			1.58	5.68	5.65	39.14	3.83	3.38	1.49	1.87	15.31	23.37
LSD			1.11	2.94	7.71	2.78	0.39	0.74	1.70	2.08	0.76	1.59
Max. Mean			55.43	44.50	91.16	13.28	7.23	15.00	70.95	69.83	4.00	9.00
Min. Mean			48.38	32.80	55.73	1.77	4.51	11.00	61.20	60.54	2.00	1.00
No. of Reps			3	3	2	2	2	2	2	2	2	2

Disease Reactions

Entry	Name	Pedigree	06MN BYDV	06ILL BYDV	04UG CRST	05UG CRST D1	05UG CRST D2	05MN SMUT	06MN SMUT D1
1	CDC Weaver		---	---	---	---	---	---	---
2	CDC Dancer		---	---	---	---	---	---	---
3	OT3017		---	---	---	---	---	---	---
4	AC Morgan		---	---	---	---	---	---	---
7	SA04800	SA00406/Furlong	2	4.0	0	2	4	0	0
25	SA04876	SA00489/Furlong	2	4.5	0	0	5	0	0

Trial: 2006 SOYT#2

Agronomic

Entry	Name	Pedigree	Yield (kg/ha)	Yield as %Dancer	Days to Head	Days to Mature	Plant Ht. (cm)	Ht. Sco. (1 - 9)	Lodging (1 - 9)	Visual Sco. (1 - 9)	Vis.Sco-tz (1 - 9)
1	CDC Weaver		6065	97	57.6	97.3	119.3	6.3	5.4	5.3	5.7
2	CDC Dancer		6259	100	56.8	95.1	120.1	5.3	3.7	6.8	7.0
3	CDC SO-I		6298	101	56.7	95.4	112.1	4.3	2.0	6.4	5.5
4	AC Morgan		6201	99	57.2	98.1	117.3	6.0	2.7	6.3	6.8
21	SA04367	AC Assiniboia/IA91098-2-4	5153	82	56.6	95.6	121.9	5.7	2.6	4.7	5.2
22	SA04377	AC Assiniboia/IA91098-2-4	5447	87	59.8	98.1	119.9	5.7	5.3	3.7	4.7
26	SA04840	SA00406/SA00657	5965	95	55.2	93.6	121.1	6.3	2.9	5.7	5.3
GRAND MEAN			5888.0		57.23	96.48	118.85	5.77	3.93	5.62	5.70
CV			8.3		1.48	2.08	3.38	10.00	44.20	21.95	17.46
LSD			269.3		0.66	1.56	3.13	0.79	1.35	0.83	0.95
Max. Mean			6451		60.89	100.67	128.11	7.00	6.33	7.67	7.00
Min. Mean			5055		54.33	92.56	109.56	4.33	2.00	3.67	4.33
No. of Reps			18		9	9	9	3	9	12	6

Kernel Quality

Entry	Name	Pedigree	Test Wt. (kg/hl)	Kernel Wt. (g/1000k)	Plump (%>5.5)	Thin (%<5.0)	NIT Oil (%)	NIT Prot (%)	NIT Grt (%)	Codema Grt (%)	Vis. Brk (1 - 9)	Hull Col. (1 - 9) (Ker)
1	CDC Weaver		51.2	41.8	87.0	2.9	5.1	13.3	70.0	69.2	3.0	3.0
2	CDC Dancer		52.9	34.5	82.2	3.9	5.2	11.2	71.4	68.4	3.0	2.0
3	CDC SO-I		48.3	40.4	88.7	3.0	5.4	13.5	65.4	63.9	3.0	9.0
4	AC Morgan		50.4	37.1	74.5	5.6	5.2	13.8	63.6	61.4	3.0	2.0
21	SA04367	AC Assiniboia/IA91098-2-4	48.5	33.1	56.7	12.8	7.5	14.2	70.4	62.8	2.0	9.0
22	SA04377	AC Assiniboia/IA91098-2-4	45.3	32.2	49.5	15.3	7.8	14.9	71.0	63.5	2.5	9.0
26	SA04840	SA00406/SA00657	48.9	31.8	69.5	7.5	6.4	14.4	69.9	67.0	2.5	3.0
GRAND MEAN			50.97	35.27	75.72	5.81	5.93	13.38	67.29	65.65	2.88	4.26
CV			1.83	5.00	6.89	29.27	16.32	10.68	1.94	2.06	17.01	67.46
LSD			1.27	2.40	8.81	2.87	1.64	2.41	2.21	2.29	0.83	0.00
Max. Mean			54.09	41.80	88.66	15.31	7.76	15.50	71.40	69.71	4.50	9.00
Min. Mean			45.29	29.68	49.49	1.93	4.27	11.20	62.50	61.41	2.00	1.00
No. of Reps			3	3	2	2	2	2	2	2	2	1

Disease Reactions

Entry	Name	Pedigree	06MN BYDV	06ILL BYDV	06MN SLRUST	04UG CRST	05UG CRST D1	05UG CRST D2	05COMM CR	05MN SMUT	06MN SMUT D1
1	CDC Weaver		---	---	---	---	---	---	---	---	---
2	CDC Dancer		---	---	---	---	---	---	---	---	---
3	CDC SO-I		---	---	---	---	---	---	---	---	---
4	AC Morgan		---	---	---	---	---	---	---	---	---
21	SA04367	AC Assiniboia/IA91098-2-4	---	4.5	>20	6	3	6	---	0	0
22	SA04377	AC Assiniboia/IA91098-2-4	2	4.5	a few >20	0	3	5	---	0	0
26	SA04840	SA00406/SA00657	---	6.5	---	0	1	3	SR	0	0

2006 POYT#1
Agronomic and Kernel Quality

Entry	Name	Pedigree	Yield (kg/ha)	Days to Head	Vis-BGR (1 - 9)	Vis-TZ (1 - 9) (Ker)	Test Wt. (kg/hl) (Ker)	Kern Wt. (g/1000k) (Ker)	%Plump (%>5.5) (Ker)	NIT Oil (%) (Ker)	NIT Prot (%) (Ker)	NIT Grt (%) (Ker)	Cod Grt (%) (Ker)	Vis Brk (1 - 9) (Ker)	Hull Col. (1 - 9) (Ker)
1	CDC Weaver		5366	59.2	3.7	4.0	52.5	39.6	85.3	6.2	12.6	71.7	70.8	3.0	3.0
2	CDC SO-I		5082	57.0	7.2	6.0	50.1	37.6	90.8	6.7	14.0	69.8	64.9	2.0	7.0
9	SO03783	SA97404/SA97496 F1//AC Assiniboia	4929	56.8	3.7	4.7	53.3	35.2	95.9	7.6	14.3	72.0	65.6	3.0	7.0
10	SA02984	SA97404/SA97496	5074	55.8	4.3	6.3	55.4	32.2	85.2	8.7	13.3	71.4	65.3	2.0	3.0
17	SA04366	AC Assiniboia/IA91098-2-4	4691	55.7	3.2	4.0	49.7	28.8	53.8	8.8	13.7	72.0	65.1	2.0	3.0
21	SO02177-02	AC Assiniboia/SA96121	4669	57.3	6.5	6.7	53.5	33.1	85.5	7.3	13.8	70.4	66.0	2.0	9.0
22	SO02177-03	AC Assiniboia/SA96121	4591	58.7	7.2	6.0	53.4	29.4	65.8	7.9	16.6	68.7	65.8	2.0	9.0
23	SO02177-04	AC Assiniboia/SA96121	4528	57.5	6.3	6.7	55.0	32.2	86.6	7.4	14.2	72.0	67.6	2.0	9.0
24	SO02177-05	AC Assiniboia/SA96121	4626	57.2	7.2	6.3	53.8	32.4	87.8	7.4	13.7	71.1	65.7	2.0	9.0
25	SO02177-06	AC Assiniboia/SA96121	4374	57.3	6.3	6.3	53.7	31.0	85.6	7.8	14.3	68.1	65.4	2.0	9.0
GRAND MEAN			4848.4	57.97	5.19	5.44	53.50	34.16	83.74	6.63	13.39	70.71	66.90	2.56	4.92
CV			8.3	1.00	24.20	15.21	2.97	9.45	10.79	16.11	9.00	2.02	3.12	22.32	52.35
LSD			386.8	0.56	1.20	1.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max. Mean			5366.1	61.50	7.17	7.67	55.65	42.10	96.45	8.81	16.60	72.80	71.16	4.00	9.00
Min. Mean			4374.1	55.67	3.17	3.33	49.69	28.80	53.81	4.87	11.00	67.90	61.87	2.00	1.00
No. of Reps			6	6	6	3	1	1	1	1	1	1	1	1	1

2006 POYT#1
Disease Reactions

Entry	Name	Pedigree	06MN BYDV	06ILL BYDV	06MN SLRUST	06MN SMUT D1	06UG CRST D1	06UG CRST D2
1	CDC Weaver		---	---	---	---	---	---
2	CDC SO-I		---	---	---	---	---	---
9	SO03783	SA97404/SA97496 F1//AC Assiniboia	---	4	>20	10	3	7
10	SA02984	SA97404/SA97496	2	6	---	80	2	6
17	SA04366	AC Assiniboia/IA91098-2-4	---	5	>20	0	5	7
21	SO02177-02	AC Assiniboia/SA96121	2	6	some >20	40	2	7
22	SO02177-03	AC Assiniboia/SA96121	2	4.5	---	25	4	9
23	SO02177-04	AC Assiniboia/SA96121	2	4	---	70	3	7
24	SO02177-05	AC Assiniboia/SA96121	2	3.5	>20	70	2	6
25	SO02177-06	AC Assiniboia/SA96121	---	4.5	>20	70	3	6

2006 POYT#2

Agronomic and Kernel Quality

Entry	Name	Pedigree	Yield (kg/ha)	Days to Head	Vis-BGR (1 - 9)	Vis-TZ (1 - 9) (Ker)	Test Wt. (kg/hl) (Ker)	Kern Wt. (g/1000k) (Ker)	%Plump (%>5.5) (Ker)	NIT Oil (%) (Ker)	NIT Prot (%) (Ker)	NIT Grt (%) (Ker)	Cod Grt (%) (Ker)	Vis Brk (1 - 9) (Ker)	Hull Col. (1 - 9) (Ker)
1	CDC Weaver		5107	59.3	4.5	5.0	50.4	38.0	84.5	6.3	13.0	70.9	67.2	3.0	3.0
2	CDC SO-I		5075	57.5	7.3	7.0	48.0	37.0	88.0	6.7	14.4	68.5	63.7	3.0	8.0
3	CDC Dancer		4814	59.3	6.5	7.5	52.0	30.5	83.2	4.8	10.6	72.0	68.1	3.0	3.0
4	SA050003	AC Assiniboia/OT386 F1//SA96121	4420	59.0	5.3	4.5	52.2	33.5	81.6	7.8	14.5	70.1	67.5	2.0	3.0
5	SA050005	AC Assiniboia/OT386 F1//SA96121	4739	59.8	6.3	6.0	51.3	33.0	83.2	8.5	14.2	70.0	67.4	2.0	3.0
6	SA050014	AC Assiniboia/OT386 F1//IA9108-24	4140	59.3	5.0	6.0	50.5	35.0	82.0	7.4	14.9	70.5	64.5	4.0	3.0
7	SA050019	CDC Dancer/IA91098-2//AC Assiniboia	4344	58.0	5.3	7.5	47.4	30.0	63.5	7.1	13.4	70.9	65.3	3.0	8.0
8	SA050029	CDC Dancer/IA91098-2//AC Assiniboia	4655	58.0	3.8	5.5	51.0	32.0	78.2	8.5	12.9	70.6	66.4	2.0	8.0
9	SA050038	SA97404/SA97496 F1//AC Assiniboia	4715	59.3	3.8	6.0	50.3	38.0	82.2	7.4	14.3	69.1	64.8	2.0	9.0
10	SA050039	SA97404/SA97496 F1//AC Assiniboia	4454	58.8	5.8	5.0	49.3	32.0	87.2	7.3	13.4	71.1	66.7	2.0	8.0
11	SA050409	SA00406/Furlong	4646	57.5	6.3	6.0	51.1	31.5	66.6	6.8	13.7	71.2	63.7	2.0	7.0
12	SA050412	SA00406/Furlong	4562	57.3	5.3	5.5	49.7	33.5	80.7	6.6	13.8	72.2	66.2	3.0	3.0
13	SA050416	SA00406/SA00657	4497	57.3	5.8	5.5	49.2	29.0	68.2	7.9	13.8	70.6	64.8	2.0	3.0
14	SA050421	SA00406/SA00657	4575	56.0	5.8	6.0	46.0	30.0	79.0	7.4	13.9	71.4	65.1	2.0	3.0
15	SA050425	SA00406/SA00657	4601	58.3	6.3	6.0	48.2	27.0	49.7	8.0	14.1	72.0	64.3	2.0	3.0
16	SA050434	Furlong/SA00523	4748	58.5	7.3	6.5	49.9	33.5	77.3	6.6	14.4	71.4	65.0	3.0	9.0
17	SA050436	Furlong/SA00523	4479	57.3	6.8	6.5	51.5	38.5	91.3	6.9	14.7	72.5	68.5	2.0	8.0
18	SA051084	SA02842/AC Assiniboia	5140	59.0	5.5	5.0	51.3	33.5	90.4	6.1	11.8	72.4	70.1	4.0	7.0
19	SA051087	SA02842/AC Assiniboia	4681	59.3	4.8	4.0	52.6	34.5	90.8	6.1	12.3	73.9	67.8	4.0	8.0
20	SA051097	SA02842/AC Assiniboia	4995	58.5	7.0	6.0	51.6	32.0	82.9	6.0	12.1	73.1	66.3	3.0	9.0
21	SA051099	SA02842/AC Assiniboia	4251	59.8	5.5	6.0	52.3	33.5	81.8	6.2	14.5	71.9	66.9	4.0	8.0
22	SA050463	SA00489/SA00657	4901	59.5	4.8	6.5	52.1	28.5	81.7	7.3	12.4	72.2	68.2	2.0	7.0
23	SA050464	SA00489/SA00657	4779	56.0	6.0	7.0	51.4	32.5	83.5	6.9	13.4	72.3	68.6	2.0	7.0
24	SA050468	SA00489/SA00657	4536	57.0	4.0	4.0	52.2	33.5	86.7	6.6	12.5	73.9	71.1	3.0	7.0
25	SA050472	SA00489/SA00657	4718	59.5	5.5	5.5	51.8	29.5	71.4	7.6	13.0	67.0	66.5	3.0	7.0
26	SA051001	01-499-04-227/OT394	4909	60.0	5.5	7.5	47.6	28.5	57.7	6.4	12.0	71.2	63.9	3.0	7.0
27	SA051038	01-499-03-265/OT2012	4850	59.0	4.8	5.5	51.4	29.0	40.1	8.2	12.9	69.8	64.1	3.0	7.0
28	SA051042	01-499-03-265/OT2012	4472	60.0	5.5	6.5	50.2	28.0	44.5	8.5	12.8	69.3	63.1	3.0	7.0
29	SA051043	01-499-03-265/OT2012	4144	55.5	4.5	6.5	48.4	34.5	89.4	8.6	16.3	69.2	66.2	3.0	8.0
30	SA051051	01-499-03-265/OT2012	4078	55.5	3.0	4.5	51.4	32.0	80.5	7.9	13.3	71.6	68.1	3.0	8.0
31	SA051482	OT3004/01-499-03-265	4554	55.8	5.0	6.5	50.1	39.2	72.1	9.4	13.4	68.7	67.0	3.0	7.0
32	SA051491	OT3004/01-499-03-265	4931	57.0	7.3	7.5	50.5	34.0	70.2	9.4	13.4	68.7	64.9	2.0	7.0
33	SA051526	OT3004/01-499-03-265	4557	57.0	6.0	6.0	48.9	33.5	63.0	9.1	14.1	59.7	66.1	3.0	7.0
34	SA051442	OT3004/01-499-04-227	4808	61.5	3.8	4.5	49.7	29.5	69.9	8.0	12.8	69.7	64.1	3.0	8.0
35	SA051470	OT3004/01-499-04-227	4377	60.3	4.3	4.0	51.3	35.5	85.0	7.1	11.8	70.0	66.1	4.0	7.0
36	SA051478	OT3004/01-499-04-227	4919	60.5	3.8	4.0	52.1	31.0	70.5	7.8	13.6	72.1	65.4	3.0	8.0
GRAND MEAN			4643.6	58.35	5.35	5.81	50.41	32.62	76.06	7.36	13.40	70.60	66.20	2.78	6.47
CV			5.2	0.95	20.27	15.07	3.14	9.42	16.58	13.79	7.97	3.39	2.77	24.17	32.26
LSD			286.6	0.65	1.28	1.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max. Mean			5140.2	61.50	7.25	7.50	52.62	39.20	91.26	9.39	16.30	73.90	71.13	4.00	9.00
Min. Mean			4078.4	55.50	3.00	4.00	46.04	27.00	40.13	4.79	10.60	59.70	63.13	2.00	3.00
No. of Reps			4	4	4	2	1	1	1	1	1	1	1	1	1

2006 POYT#2

Disease Reactions

Entry	Name	Pedigree	06MN BYDV	06ILL BYDV	06MN SLRUST	06MN SMUT D1	05UG CRST D1	05UG CRST D2	06UG CRST D1	06UG CRST D2
1	CDC Weaver		---	---	---	---	---	---	---	---
2	CDC SO-I		---	---	---	---	---	---	---	---
3	CDC Dancer		---	---	---	---	---	---	---	---
4	SA050003	AC Assiniboia/OT386 F1//SA96121	2	7.5	---	0	---	---	3	6
5	SA050005	AC Assiniboia/OT386 F1//SA96121	2	8.5	---	0	---	---	3	6
6	SA050014	AC Assiniboia/OT386 F1//IA9108-24	2	5	some >20	0	---	---	6	8
7	SA050019	CDC Dancer/IA91098-2//AC Assiniboia	---	4	>20	1	---	---	4	7
8	SA050029	CDC Dancer/IA91098-2//AC Assiniboia	---	5	a few >20	0	---	---	3	7
9	SA050038	SA97404/SA97496 F1//AC Assiniboia	---	3	---	0	---	---	4	6
10	SA050039	SA97404/SA97496 F1//AC Assiniboia	---	6	---	40	---	---	1	5
11	SA050409	SA00406/Furlong	---	3.5	>20	0	2	5	3	6
12	SA050412	SA00406/Furlong	2	4	---	30	3	6	2	5
13	SA050416	SA00406/SA00657	2	8.5	---	30	2	5	3	6
14	SA050421	SA00406/SA00657	---	6.5	---	50	0	4	2	5
15	SA050425	SA00406/SA00657	2	6	---	0	0	1	1	5
16	SA050434	Furlong/SA00523	2	4.5	some >20	0	3	-	3	6
17	SA050436	Furlong/SA00523	2	3.5	---	5	2	6	4	7
18	SA051084	SA02842/AC Assiniboia	2	8	---	1	---	---	5	7
19	SA051087	SA02842/AC Assiniboia	---	5	>20	0	---	---	4	6
20	SA051097	SA02842/AC Assiniboia	2	4.5	---	0	---	---	4	6
21	SA051099	SA02842/AC Assiniboia	2	3.5	---	10	---	---	4	6
22	SA050463	SA00489/SA00657	2	8.5	---	15	---	---	1	5
23	SA050464	SA00489/SA00657	2	8	---	40	---	---	5	7
24	SA050468	SA00489/SA00657	2	8	some >20	15	---	---	2	5
25	SA050472	SA00489/SA00657	2	8	>20	0	---	---	0	4
26	SA051001	01-499-04-227/OT394	2	6	---	0	---	---	2	5
27	SA051038	01-499-03-265/OT2012	---	7	>20	10	3	7	4	7
28	SA051042	01-499-03-265/OT2012	2	6.5	a few >20	5	3	7	5	7
29	SA051043	01-499-03-265/OT2012	---	6	>20	0	3	6	3	7
30	SA051051	01-499-03-265/OT2012	---	7.5	>20	0	5	-	4	8
31	SA051482	OT3004/01-499-03-265	---	6	>20	0	---	---	5	8
32	SA051491	OT3004/01-499-03-265	---	6	>20	0	---	---	4	8
33	SA051526	OT3004/01-499-03-265	---	5	>20	0	---	---	4	7
34	SA051442	OT3004/01-499-04-227	---	5	>20	0	---	---	3	6
35	SA051470	OT3004/01-499-04-227	---	7.5	>20	0	---	---	1	4
36	SA051478	OT3004/01-499-04-227	2	4.5	---	0	---	---	3	7

2006 POYT#3
Agronomic and Kernel Quality

Entry	Name	Pedigree	Yield (kg/ha)	Days to Head	Vis-BGR (1 - 9)	Vis-TZ (1 - 9) (Ker)	Test Wt. (kg/hl) (Ker)	Kern Wt. (g/1000k) (Ker)	%Plump (%>5.5) (Ker)	NIT Oil (%) (Ker)	NIT Prot (%) (Ker)	NIT Grt (%) (Ker)	Cod Grt (%) (Ker)	Vis Brk (1 - 9) (Ker)	Hull Col. (1 - 9) (Ker)
1	CDC Weaver		5213	60.0	4.3	6.0	51.9	32.1	84.6	6.5	12.8	69.8	68.7	3.0	3.0
2	CDC SO-I		4970	58.0	6.5	7.0	49.5	37.4	84.0	6.8	15.0	67.9	63.6	3.0	7.0
3	CDC Baler		3000	66.8	7.3	5.0	49.4	34.2	81.8	4.8	12.9	66.5	62.7	4.0	2.0
4	CDC Dancer		5082	59.0	6.3	6.5	51.9	29.9	73.8	5.4	12.8	71.9	68.2	3.0	3.0
5	SA051053	SA02842/AC Assiniboia	4945	58.8	7.0	6.5	51.6	30.7	83.0	10.9	20.9	61.2	65.7	3.0	10.0
6	SA051056	SA02842/AC Assiniboia	4407	62.3	5.3	6.0	49.3	34.1	75.6	7.7	17.0	60.8	65.0	4.0	10.0
7	SA051059	SA02842/AC Assiniboia	4590	60.3	5.0	6.5	51.4	41.2	88.2	12.5	23.2	77.2	66.3	4.0	10.0
8	SA051062	SA02842/AC Assiniboia	4551	61.0	6.0	6.5	52.2	41.9	93.9	8.6	17.8	62.2	68.6	4.0	10.0
9	SA051072	SA02842/AC Assiniboia	4933	60.8	5.3	7.0	53.1	40.7	94.2	9.5	18.8	59.2	66.2	5.0	10.0
10	SA051076	SA02842/AC Assiniboia	4467	61.3	7.0	6.0	54.4	42.5	90.1	9.8	21.6	87.7	66.1	5.0	10.0
11	SA050442	SA00523/SA00657	5154	58.8	6.0	6.0	53.8	36.3	84.4	6.9	14.9	71.3	67.6	3.0	7.0
12	SA050445	SA00523/SA00657	4556	58.8	6.0	6.5	51.7	32.9	83.9	6.4	13.3	70.8	65.6	3.0	7.0
13	SA050447	SA00523/SA00657	4722	58.5	7.0	7.5	51.3	35.9	79.4	7.2	13.5	69.2	65.3	3.0	3.0
14	SA050450	SA00523/SA00657	5008	59.5	5.8	6.5	52.0	33.7	85.0	6.5	14.0	71.8	67.4	3.0	7.0
15	SA050452	SA00523/SA00657	4714	58.8	5.8	5.5	51.9	34.2	80.2	6.7	14.7	68.7	65.9	3.0	7.0
GRAND MEAN			4293.5	62.06	6.19	6.44	50.58	35.18	81.94	6.14	14.43	67.94	64.22	3.94	4.67
CV			7.3	0.81	23.81	12.16	3.82	10.55	14.32	31.83	18.56	7.01	3.59	21.50	60.40
LSD			367.2	0.59	1.74	1.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max. Mean			5213.3	66.75	8.25	8.00	54.41	43.40	97.11	12.46	23.20	87.70	68.71	5.00	10.00
Min. Mean			2999.5	58.00	4.25	4.50	45.47	27.90	45.19	3.79	12.20	59.20	60.70	3.00	2.00
No. of Reps			4	4	4	2	1	1	1	1	1	1	1	1	1

2006 POYT#3
Disease Reactions

Entry	Name	Pedigree	06MN BYDV	06ILL BYDV	06MN SLRUST	06MN SMUT D1	06MN SMUT D2	05UG CRST D1	05UG CRST D2	05COMM CR	06UG CRST D1	06UG CRST D2
1	CDC Weaver		---	---	---	---	---	---	---	---	---	---
2	CDC SO-I		---	---	---	---	---	---	---	---	---	---
3	CDC Baler		---	---	---	---	---	---	---	---	---	---
4	CDC Dancer		---	---	---	---	---	---	---	---	---	---
5	SA051053	SA02842/AC Assiniboia	2	5.5	---	0	---	---	---	---	4	6
6	SA051056	SA02842/AC Assiniboia	2	7.5	---	0	0	---	---	---	5	8
7	SA051059	SA02842/AC Assiniboia	2	4	---	0	0	---	---	---	3	7
8	SA051062	SA02842/AC Assiniboia	2	6	---	0	0	---	---	---	3	6
9	SA051072	SA02842/AC Assiniboia	2	6	>20	1	5	---	---	---	3	6
10	SA051076	SA02842/AC Assiniboia	2	5.5	---	0	10	---	---	---	5	7
11	SA050442	SA00523/SA00657	---	3.5	>20	1	---	3	-	---	3	7
12	SA050445	SA00523/SA00657	2	3.5	---	20	---	2	5	---	4	7
13	SA050447	SA00523/SA00657	2	4	---	0	---	1	-	---	2	5
14	SA050450	SA00523/SA00657	---	4	>20	0	---	1	2	S	0	2
15	SA050452	SA00523/SA00657	---	7	>20	0	---	1	2	---	0	4

2006 POYT#10

Agronomic and Kernel Quality

Entry	Name	Pedigree	Yield (kg/ha)	Days to Head	Vis-BGR (1 - 9)	Vis-TZ (1 - 9) (Ker)	Test Wt. (kg/hl) (Ker)	Kern Wt. (g/1000k) (Ker)	%Plump (%>5.5) (Ker)	NIT Oil (%) (Ker)	NIT Prot (%) (Ker)	NIT Grt (%) (Ker)	Cod Grt (%) (Ker)	Vis Brk (1 - 9) (Ker)	Hull Co (1 - 9) (Ker)
1	CDC SO-I		4421	57.2	7.2	5.7	51.8	35.0	92.0	6.8	14.9	68.1	65.2	3.0	8.
2	CDC Dancer		4425	58.8	7.2	7.0	53.9	29.3	74.8	5.4	11.9	72.7	68.4	3.0	3.
3	CDC Weaver		4505	58.8	5.2	6.0	54.0	40.2	84.0	5.8	12.8	72.1	72.2	3.0	3.
4	SA02995		3925	56.3	4.7	7.0	56.3	31.6	74.3	8.7	15.4	67.4	66.8	2.0	2.
5	CDC Sol-Fi		3711	58.8	5.3	6.7	52.5	28.8	60.6	4.3	14.4	66.1	63.6	3.0	7.
6	AC Morgan		3775	59.7	5.2	5.7	50.3	30.1	68.3	5.0	12.8	68.3	62.5	3.0	3.
7	AC Assiniboia		4174	58.8	4.7	5.3	52.3	34.4	79.0	5.5	13.8	71.2	67.4	3.0	9.
8	SO04319	Dancer/IA91098-2 F1//Assiniboia	3835	55.5	2.8	5.3	51.4	26.7	71.4	7.0	14.7	72.9	67.2	3.0	8.
9	SO04328	SA97404/SA97496 F1//Assiniboia	3890	56.5	5.2	5.3	53.5	35.2	92.2	7.8	15.3	72.0	67.0	3.0	8.
10	SA04823	SA00406/SA00657	3800	55.3	2.8	5.0	52.5	35.0	82.2	7.0	16.3	77.0	70.5	3.0	7.
11	SO02177-04	AC Assiniboia/SA96121	4070	58.0	4.8	5.3	55.3	33.0	84.6	7.4	15.1	69.5	68.1	2.0	9.
12	SO02177-06	AC Assiniboia/SA96121	3830	58.2	5.0	5.7	54.0	30.9	75.0	7.4	15.8	70.1	67.0	3.0	9.
13	SA051508		3898	61.0	4.8	4.0	52.7	36.5	81.5	7.9	14.3	69.3	68.6	2.0	7.
14	SA051509		4169	58.9	6.4	6.0	52.7	40.7	90.0	7.7	14.3	68.0	69.6	3.0	7.
15	SA051449		4184	60.9	4.0	4.0	51.6	30.7	70.6	7.9	13.5	69.1	64.9	2.0	3.
16	SA051462		4125	61.3	5.2	4.7	53.0	31.2	74.6	7.4	13.8	73.5	70.8	3.0	7.
17	SA051471		3957	60.5	4.7	4.0	52.7	30.7	68.7	6.9	13.8	72.8	65.6	3.0	8.
GRAND MEAN			3913.4	58.04	4.94	5.52	53.03	31.48	69.57	6.96	14.69	69.98	66.70	2.90	5.2
CV			7.6	1.03	23.79	16.22	2.48	11.92	24.99	24.93	7.41	3.73	4.23	18.57	46.2
LSD			285.9	0.57	1.12	1.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Max. Mean			4504.8	61.33	7.17	7.00	56.28	40.70	92.23	11.30	17.30	77.00	72.24	4.00	9.0
Min. Mean			3426.5	55.33	2.83	4.00	50.33	23.70	26.62	3.90	11.90	65.40	59.45	2.00	2.0
No. of Reps			6	6	6	3	1	1	1	1	1	1	1	1	

UNIVERSITY OF SASKATCHEWAN

RESEARCH NEWS
Office of the Vice-President Research
University of Saskatchewan
Box 5000 RPO University
110 Gymnasium Place
SASKATOON SK S7N 4J8
Tel: (306) 966-2506 Fax: (306) 966-2411
http://www.usask.ca/research

FOR IMMEDIATE RELEASE – Wednesday, November 8, 2006

Innovative U of S-led Partnership Creates Oat Variety Breakthrough

Livestock producers will soon have access to a new variety of oat with a nutritional profile similar to barley, thanks to an innovative partnership among producers, the provincial government, and the University of Saskatchewan.

"This oat variety is the first designed to combine a more digestible hull with a higher fat content," said plant sciences professor Brian Rossnagel, an oat and barley breeder at the U of S Crop Development Centre (CDC).

"This is a significant development for the cattle feed and oat industries."

While oat is generally cheaper to grow and has higher yield potential, it packs less nutritional punch than barley because it has more hard-to-digest hull relative to kernel (or groat). The new variety, CDC SO-I, boasts a higher-fat groat and a more digestible hull. Its registration was recently approved by the Canadian Food Inspection Agency.

Now that it has been registered, CDC SO-I will go to FarmPure Seeds Inc. of Regina to produce Pedigreed seed. Commercial planting of the new variety should begin by 2009.

"This is a superb example of technology transfer, where the university, farmers, and the government have worked together to bring a really innovative variety to market," said Trenton Baisley, president of Super Oats Canada Ltd. and CEO of FarmPure Seeds.

The name of the new variety, CDC SO-I, (CDC Super Oats, variety number one) is derived from its unique genesis. The project began in 1999 as an idea at the CDC to develop better feed oat by "fast tracking" the research cycle. Rather than developing field-ready varieties for animal testing, CDC plant breeders produced prototype varieties with the desired nutritional traits.

These prototype varieties would normally need more work to bring to commercialization. Instead, collaborators at the U of S department of animal and poultry science and the Prairie Feed Resource Centre (now the Feeds Innovation Institute (FII)) conducted feed tests on livestock with the prototypes to see if the plant breeders were on the right track.

"Doing the feed testing and variety development work simultaneously allowed the research team to determine if the prototype had promise early in the process," said Scott Wright, FII executive director at the U of S department of animal and poultry science. "This helped bring CDC SO-I to market many years earlier than the traditional route."

Funding totaling $210,000 over six years was provided through Super Oats Canada, a producer-researcher consortium created in 1999. Later, the Saskatchewan government, through its Agriculture Development Fund, was inspired to join the CDC SO-I project with matching funds totaling $207,000.

"Saskatchewan Agriculture and Food and the Crop Development Centre have a long history of working together," Agriculture and Food Minister Mark Wartman said. "The success of this

project highlights the benefits of drawing on additional resources and direction from industry and other university departments."

Super Oats Canada has committed to continued funding to the CDC for improved oat varieties of this type both for the domestic market and to strengthen the position of Canada's farmers in the international arena.

"We export 90 per cent of the feeds produced in Saskatchewan," Wright said. "There are huge opportunities to create more value adding, to support and build the local feed industry, and position Saskatchewan as a world leader."

-30-

For more information, contact:

Brian Rossnagel
Professor (CDC)
Dept. of Plant Sciences
(306) 966-4976
brian.rossnagel@sask.usask.ca

Trenton Baisley
CEO, FarmPure Family of Companies
President, Super Oats Canada
(306) 791-3770 ext. 221
tbaisley@farmpure.com

Scott Wright
Executive Director
Feeds Innovation Institute
Department of Animal and Poultry Science
(306) 230-7102
scott.wright@usask.ca

Michael Robin
U of S Research Communications
(306) 966-2427
michael.robin@usask.ca

Scott Brown
Director of Communications
Saskatchewan Agriculture and Food
(306) 787-4031